United States
Department of
Agriculture

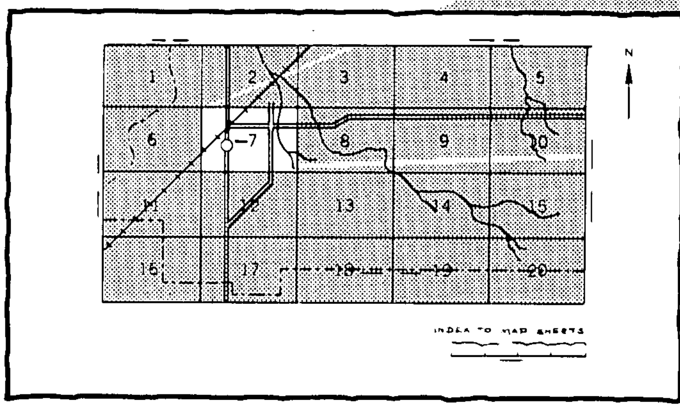
Soil
Conservation
Service

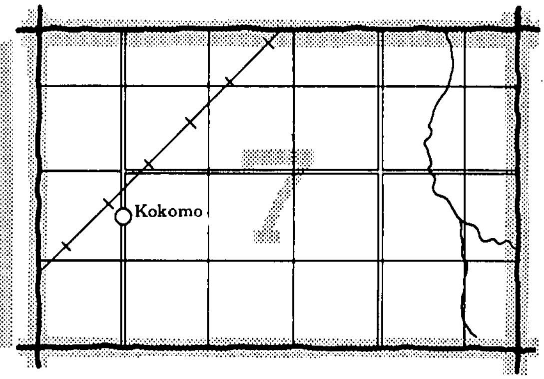
In cooperation with
North Dakota Agricultural
Experiment Station,
North Dakota Cooperative
Extension Service,
North Dakota State Soil
Conservation Committee, and
United States Department of
the Interior, Bureau of
Indian Affairs

Soil Survey of Ramsey County, North Dakota

HOW TO USE

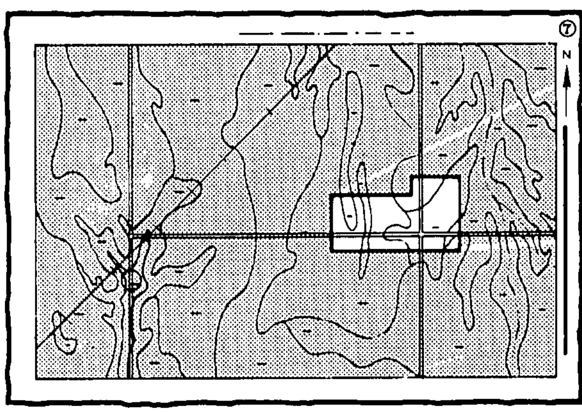
1. Locate your area of interest on the "Index to Map Sheets".

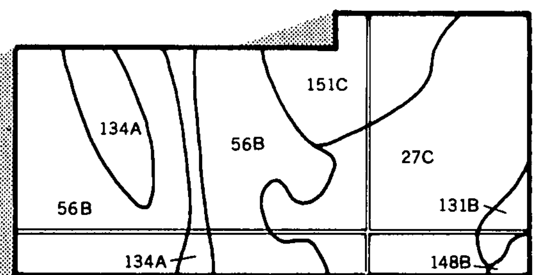




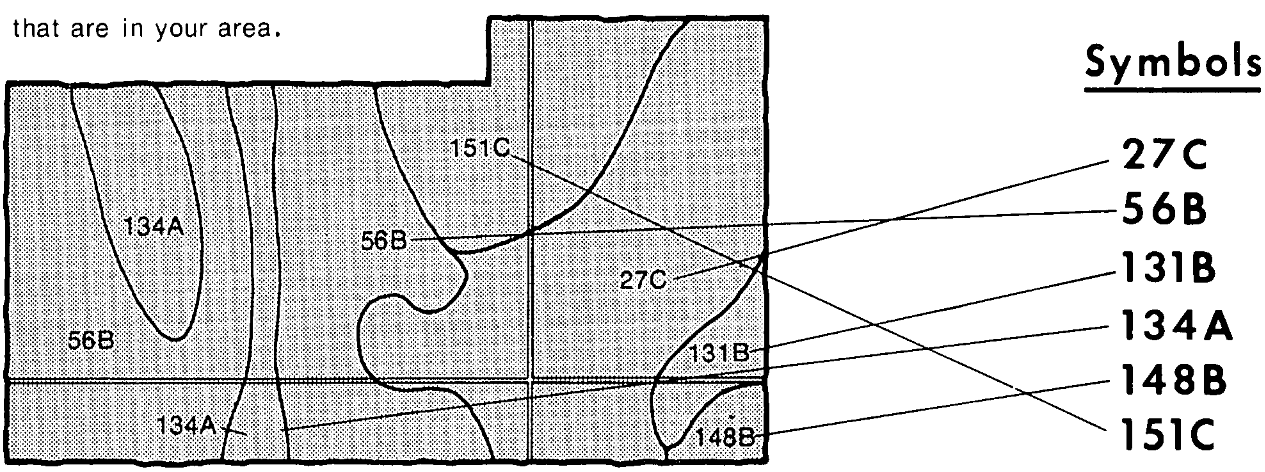
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



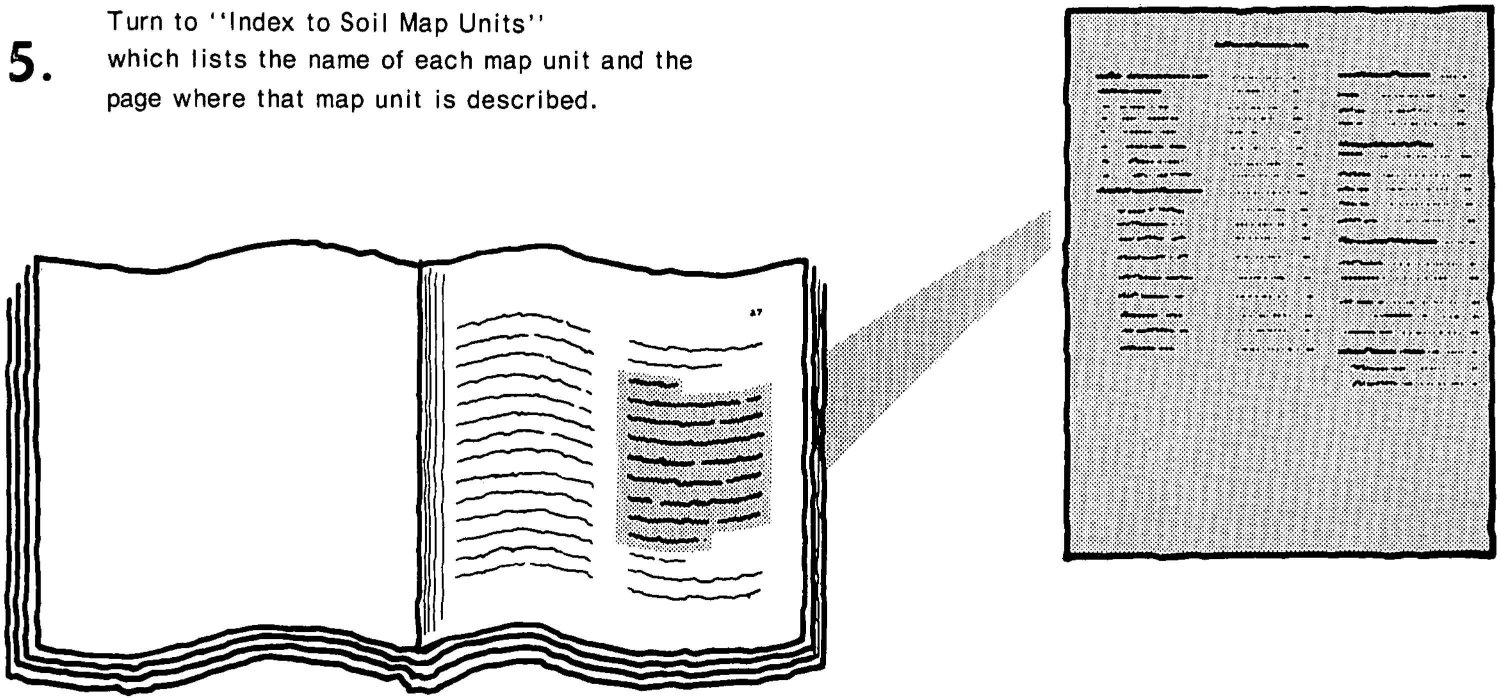


4. List the map unit symbols that are in your area.

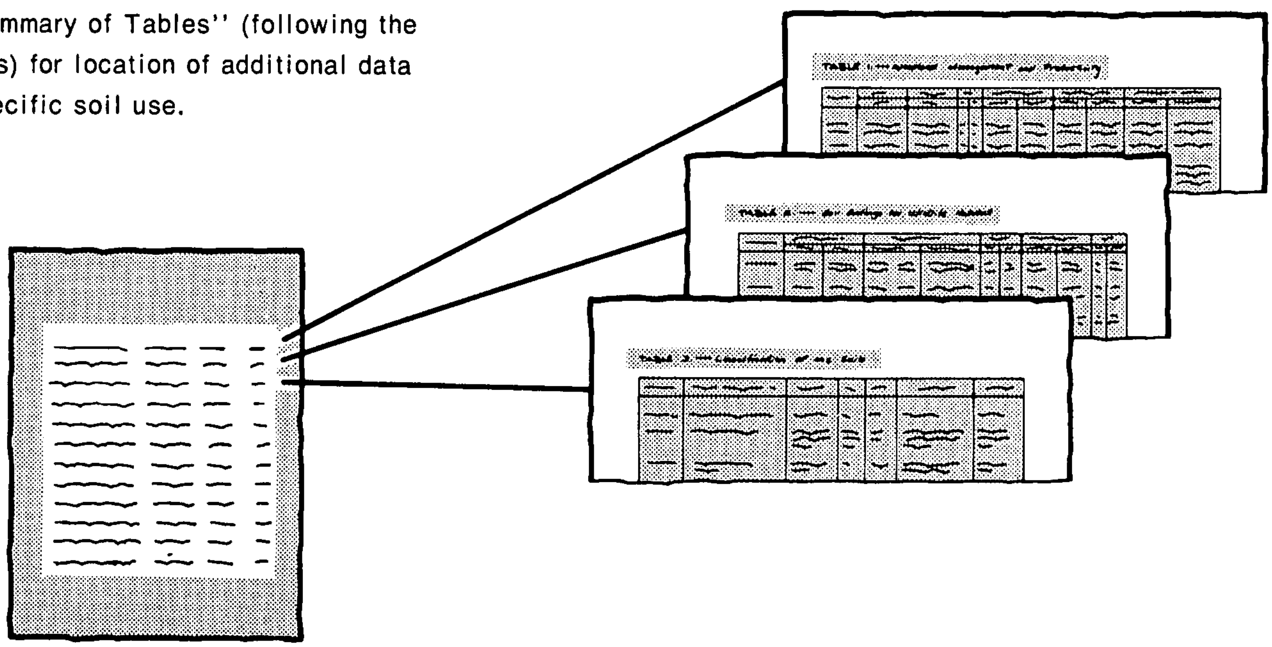


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, the North Dakota State Soil Conservation Committee, and the U.S. Department of the Interior, Bureau of Indian Affairs. It is part of the technical assistance furnished to the Ramsey County Soil Conservation District. The aerial photobase map on which the soils were delineated and published was flown in September 1975.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Farmsteads protected by windbreaks. The lighter colored areas in the center of the picture are Buse loam, and the darker ones are Svea loam. Parnell soils are in the depressions. Picture courtesy of the North Dakota State Soil Conservation Committee.

Contents

Soil Series

Issued August 1986

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Ramsey County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

August J. Dornbusch Jr.

State Conservationist
Soil Conservation Service

Soil Survey of
Ramsey County, North Dakota

By Ricky J. Bigler and Kenneth J. Liudahl, Soil Conservation Service

Fieldwork by Ricky J. Bigler, Alan R. Gulsvig, James E. Jost, Kenneth J. Liudahl, James F. Strum, and Stuart J. Larson, Soil Conservation Service, and Bertram C. Baker, professional soil classifier

Map finishing by David W. Hickcox, North Dakota State Soil Conservation Committee

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station,
North Dakota Cooperative Extension Service,
North Dakota State Soil Conservation Committee, and
United States Department of the Interior, Bureau of Indian Affairs

RAMSEY COUNTY is in the northeastern part of North Dakota (fig. 1). It has a total area of 837,760 acres, or 1,309 square miles. Of this acreage, 64,958 acres, or 101 square miles, is water. Most of the water area is Devils Lake and the chain of lakes in the central and northwestern parts of the county. The town of Devils Lake, the county seat, is in the southern part of the county.

Ramsey County is in the Drift Prairie section of the Central Lowland Province (*7*). Elevation ranges from about 1,425 feet in an area adjacent to East Devils Lake to about 1,640 feet in an area on Devils Lake Mountain. Both of these areas are in the southeastern part of the county. Most of the county lies within the basin of Devils Lake. The principal streams are Mauvais, Starkweather, and Edmore Coulees. Mauvais Coulee flows into Devils Lake and is the discharge stream for the chain of lakes in the central and northwestern parts of the county. Edmore and Starkweather Coulees flow into the chain of lakes and drain the northern and central parts of the county (fig. 2).

The western half of the county occurs as areas of glacial lacustrine and outwash sediments closely intermingled in a complex pattern with glacial till. The thickness of the lacustrine and outwash sediments varies.

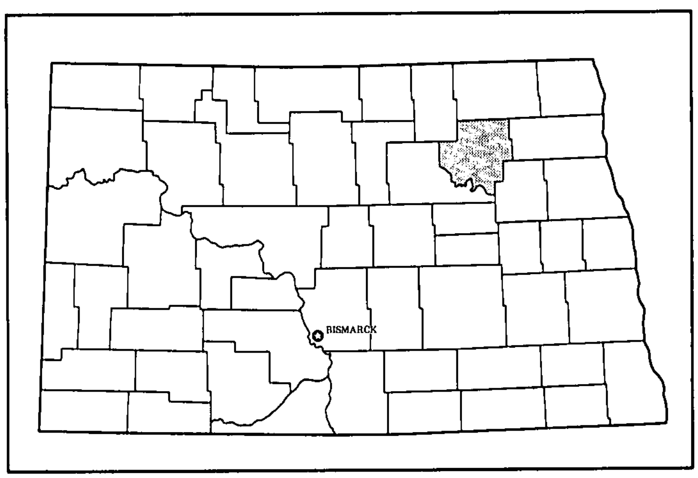


Figure 1.—Location of Ramsey County in North Dakota.

Slopes are level to gently rolling. In the eastern half of the county, the soils are nearly level to hilly. They formed mainly in glacial till, but in some small areas they formed in glacial lacustrine material, in glacial outwash, and in alluvium along drainageways and coulees.

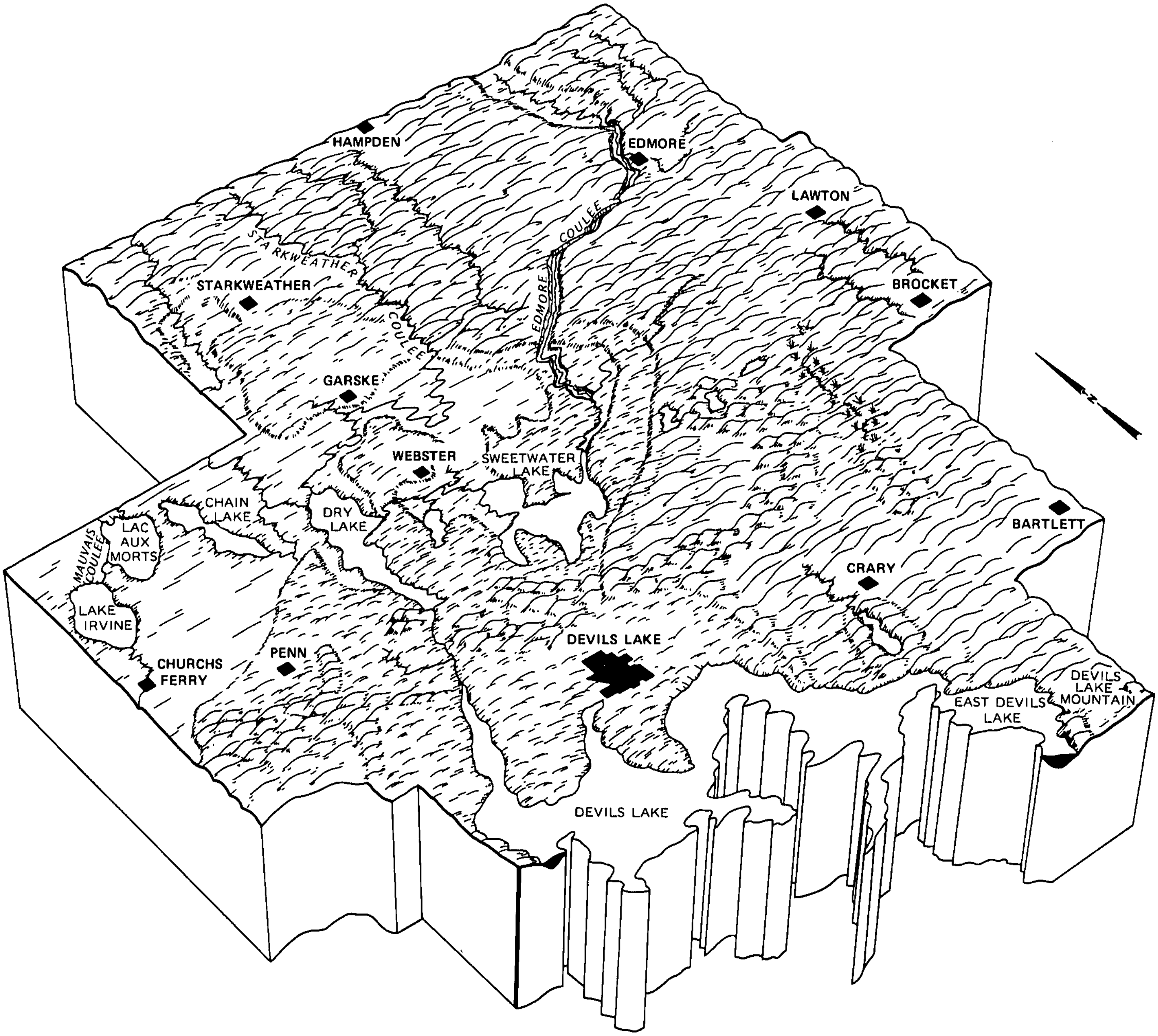


Figure 2.—Physiographic features of Ramsey County, North Dakota.

General Nature of the County

This section provides general information about the county. It describes history and development, farming, natural resources, and climate.

History and Development

The Sioux Indians were the first known inhabitants of what is now known as Ramsey County (*9*). They were nomadic, depending mostly on hunting and fishing for their livelihood.

Beginning in the late 1700's, fur traders, government exploratory expeditions, hunting parties, and fortune hun-

ters entered the area. The fur traders were employees of the Hudson Bay and Northwest Companies and, in the early 1800's, the American Fur Company. Although the fur companies established routes and started trade, they can be given little credit for the settlement of the area. In many cases, they attempted to prevent settlement in order to keep the area open for fur trade. War in the 1860's and finally the confinement of the Indians to reservations brought the fur trade to a close (*12*).

When railroads extended into the area in the 1880's, migrants from Minnesota, Wisconsin, New York, and Iowa as well as immigrants from northern Europe settled in large numbers. Land was obtained from the railroad and from the government through the Homestead Act and the Timber Culture Act. The first settlement was in Grand Harbor Township in 1880. The following year a settlement was established in Odessa Township. In 1882, Lt. Herber M. Creel established Creelsburgh on the north shore of Devils Lake (*5*). One year later the village was renamed Creel City. The name was changed again to Devils Lake in 1884, the same year that the village was made the county seat. The present boundaries of the county were established in 1890.

The population of Ramsey County was 15,199 by 1910 and 16,252 by 1930 (*10*). It began to decline in the 1930's because of drought and depression. In 1980, it was 13,048. Devils Lake, the largest town in the county, had a population of 7,442 in 1980. Other communities include Edmore, Starkweather, Crary, Lawton, Churchs Ferry, Hampden, Brocket, Webster, Bartlett, Penn, and Doyon.

Two federal highways and four state highways provide access to markets. U.S. Highway 2 and North Dakota Highways 17 and 19 are major east-west routes across the county. U.S. Highway 281 and North Dakota Highways 1 and 20 are major north-south routes. These state and federal highways along with the hard-surfaced and graveled county and township roads provide a good transportation network. The county is served by a bus line, two major rail lines, and air service.

Farming

The development of farming progressed rapidly throughout Ramsey County from the 1880's to 1900. In 1950, the county had 1,279 farms. From 1950 to 1978, the number of farms decreased to 772 (*15*). The Ramsey County Soil Conservation District was established in 1946.

The main crop grown in Ramsey County is durum wheat. Other important crops are sunflowers, spring wheat, barley, grass-legume hay, and flax. Sunflowers have become an important cash crop in the last few years. They are grown mainly for oil production. Barley is grown for feed and malting.

About 83 percent of the county is cropland, 4 percent is range and pasture, 8 percent is areas of water, and 5 percent is woodland, federal and state land, and other land. Raising livestock is a minor enterprise, as is indicated by the small acreage of range and pasture.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for crops and the grasses grazed by livestock. Other important natural resources are sand, gravel, and water.

As a result of glaciation, the county has areas of sandy and gravelly material. Some of these areas are favorable for commercial excavation. Because the quality of the deposits varies, onsite investigation is needed. Excess silt or clay is a common problem limiting the use of this material. A high content of shale is an additional problem, particularly in the northeastern part of the county.

The county has two major glacial drift aquifers (*7*). The Spiritwood aquifer underlies the southern and western parts of the county. The Starkweather aquifer underlies the central part. Devils Lake provides opportunities for water sports.

Climate

Prepared by the National Climatic Center, Ashville, North Carolina.

Ramsey County is usually quite warm in summer. Frequent spells of hot weather and occasional cool days characterize the summer. Temperatures are very cold in winter, when arctic air frequently surges over the area. Precipitation falls mainly during the warm period and is normally heaviest late in spring and early in summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Devils Lake in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 8 degrees F, and the average daily minimum temperature is -1 degree. The lowest temperature on record, which occurred at Devils Lake on January 21, 1954, is -36 degrees. In summer the average temperature is 67 degrees, and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Devils Lake on June 27, 1961, is 103 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 16.58 inches. Of this, 13 inches, or 75 percent, usually falls in April through

September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 2.5 inches at Devils Lake on June 12, 1976. Thunderstorms occur on about 35 days each year. Hail falls in scattered small areas during summer thunderstorms.

The average seasonal snowfall is about 37 inches. The greatest snow depth at any one time during the period of record was 35 inches. On the average, 54 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year. Blizzards occur several times each winter.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area

dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used to make this survey are described in the Soil Conservation Service's National Soils Handbook and the *Soil Survey Manual* (*13*). *The Major Soils of North Dakota* (*11*), *Ground-Water Basic Data for Ramsey County, North Dakota* (*6*), and *Ground-Water Resources of Ramsey County, North Dakota* (*7*), were among the references used.

Traverses were made on foot, by pickup, or by three-wheel, all-terrain cycles at an interval close enough for soil scientists to locate contrasting soil areas of about 3 acres. The soil scientists characterized all map units by transecting representative areas. One transect was made for each 1,000 acres of the map unit. A minimum of 2 and a maximum of about 10 transects were made for each map unit. Data collected from the transects were used to justify soil names and establish the range of composition of each map unit through a statistical analysis method explained by R. W. Arnold (*3*). The statistical analysis indicates that the map unit composition given in the map unit descriptions is considered to be 90 percent accurate.

All complexes had a relatively narrow range of composition, except for Hamerly-Renshaw loams, 0 to 3 percent slopes, which has numerous contrasting inclusions. For the statistical analyses, soils that could have been considered contrasting inclusions were considered similar inclusions in this one map unit. The composition of this unit varies much more than that of the other complexes in the county.

Each map unit was documented by at least one pedon description for each soil series used in its name. Laboratory data were collected in 1980 and 1981 on 11 pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department. Seven of the pedons collected in 1980 were analyzed by the North Dakota State University Soil Characterization Laboratory. Laboratory data from more than 30 additional sampled pedons were obtained during the course of the survey.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in series concepts, differing soil patterns, and differences in the design of map units, some of the boundaries and soil names on the Ramsey County general soil map do not match those on the general soil maps of Benson and Walsh Counties.

Soil Association Descriptions

Dominantly Level to Gently Rolling, Medium Textured Soils

These soils formed in glacial till on till plains. They make up about 75 percent of the county.

These soils are used primarily as cropland, but the Bottineau soils are used mostly as wooded pasture. All of the soils are well suited or suited to cropland and pasture. The principal concerns in managing cropland are controlling soil blowing and water erosion and maintaining tilth.

1. Svea-Hamerly-Barnes Association

Deep, level to gently rolling, well drained to somewhat poorly drained soils

This association is on glacial till plains. It is characterized by swales, gentle knolls, and low ridges and by scattered deep depressions and incised drainageways. Slope ranges from 0 to 9 percent.

This association makes up about 29 percent of the county. It is about 30 percent Svea soils, 20 percent Hamerly soils, 15 percent Barnes soils, and 35 percent soils of minor extent (fig. 3).

The nearly level and undulating, moderately well drained Svea soils are in the swales and on the concave lower side slopes and upper foot slopes of the ridges and knolls. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown loam.

The level to undulating, somewhat poorly drained Hamerly soils are in the swales, on concave toe slopes, and around the margins of depressions. Typically, the surface layer is black loam about 6 inches thick. The next layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is olive brown in the upper part and dark grayish brown in the lower part.

The nearly level to gently rolling, well drained Barnes soils are on the convex upper side slopes of the knolls and ridges. Typically, the surface layer is black loam about 9 inches thick. The subsoil is clay loam about 17 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is grayish brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part.

Buse, Cresbard, Parnell, and Vallers are the minor soils in this association. The well drained Buse soils are on knolls and are higher on the landscape than the Barnes soils. Their surface layer and subsoil are thin and light colored. The moderately well drained Cresbard soils are on the lower foot slopes below the Svea soils. They have an alkali (sodic) clay loam layer in the subsoil. The very poorly drained Parnell soils are in deep depressions. The poorly drained Vallers soils are adjacent to depressions and in drainageways. They are lower on the landscape than the Hamerly soils. Like the Hamerly soils, they have a layer of lime accumulation.

Most areas are used for cultivated crops. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling water erosion and soil blowing and maintaining good tilth are the main concerns in managing the soils for cultivated crops.

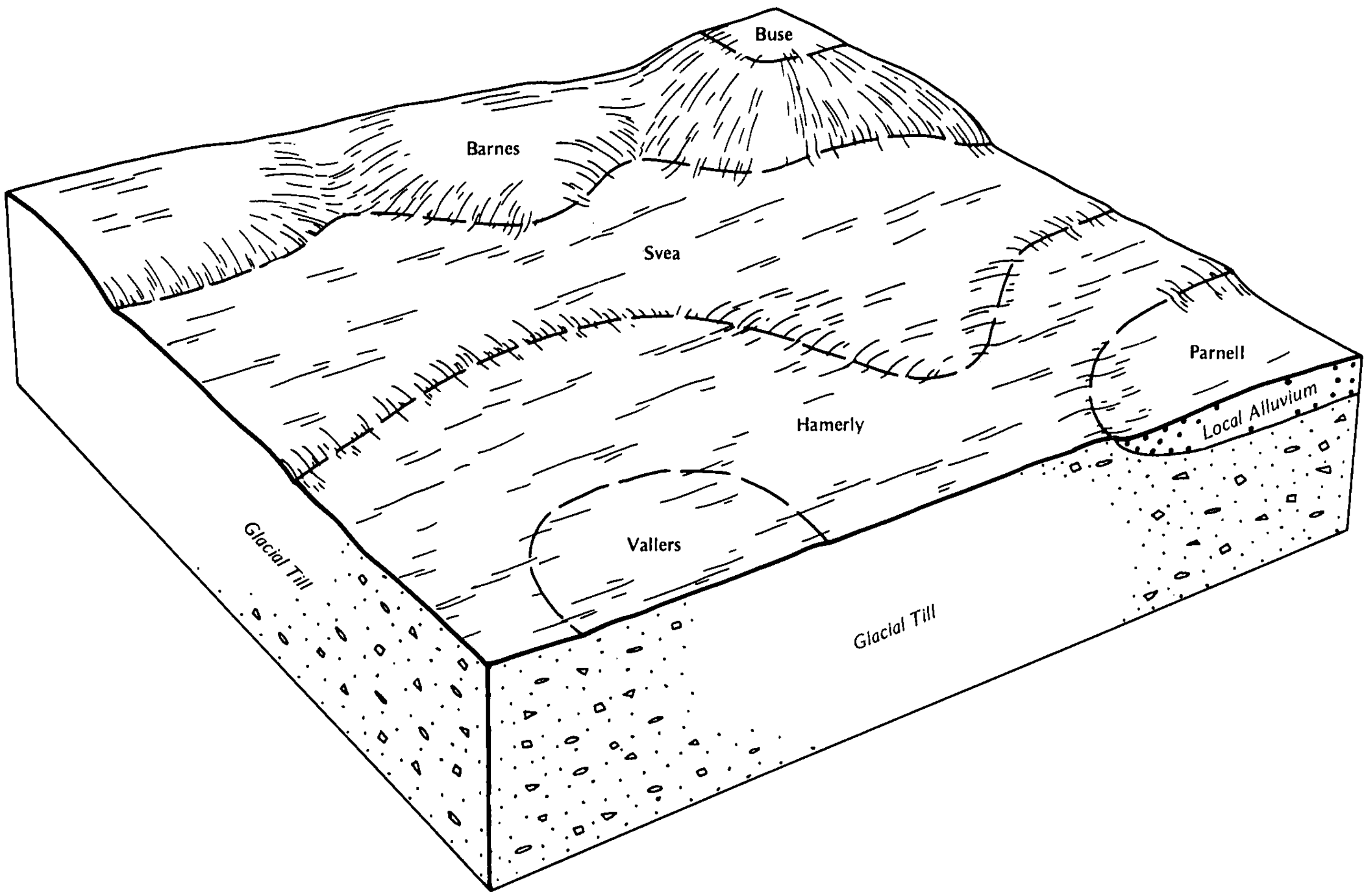


Figure 3.—Typical pattern of soils and underlying material in the Svea-Hamerly-Barnes association.

2. Svea-Vallers-Buse Association

Deep, level to gently rolling, well drained, moderately well drained, and poorly drained soils

This association is on glacial till plains. It is characterized by swales and by intervening knolls and ridges dissected by narrow drainageways. Many deep depressions and marshes and a few coulees are throughout the association. Slope ranges from 0 to 9 percent.

This association makes up about 30 percent of the county. It is about 25 percent Svea soils, 21 percent Vallers soils, 19 percent Buse soils, and 35 percent soils of minor extent.

The nearly level and undulating, moderately well drained Svea soils are in the swales and on the foot slopes of knolls and ridges. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown clay loam.

The level and nearly level, poorly drained Vallers soils are in the drainageways, on the lower toe slopes, and adjacent to the depressions, marshes, and coulees. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 12 inches thick. It is gray clay loam in the upper part and gray, mottled loam in the lower part. The upper part of the substratum is grayish brown, mottled loam. The next part is grayish brown, mottled clay loam. The lower part to a depth of about 60 inches is dark grayish brown, mottled clay loam.

The undulating and gently rolling, well drained Buse soils are on the shoulders and summits of the knolls and ridges. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is grayish brown loam about 28 inches thick. The substratum to a depth of about 60 inches is grayish brown clay loam.

Barnes, Hamerly, Parnell, and Southam are the minor soils in this association. The well drained Barnes soils are on convex side slopes between the Svea and Buse soils. Their surface layer and subsoil are thinner than

those of the Svea soils. The somewhat poorly drained Hamerly soils are on toe slopes below the Svea soils and above the Vallers soils. The very poorly drained Parnell soils are in deep depressions, and the very poorly drained Southam soils are in marshes.

Most areas are used for cultivated crops, but some low areas that have numerous deep depressions are used as pasture and hayland. This association is suited to small grain, sunflowers, and grass-legume hay. Controlling water erosion and soil blowing, maintaining good tilth, and reducing the wetness of the Vallers soils are the main concerns in managing the soils for cultivated crops. The salinity of the Vallers soils also is a concern.

3. Hamerly-Cresbard-Svea Association

Deep, level to undulating, moderately well drained and somewhat poorly drained soils

This association is on glacial till plains. It is characterized by broad, shallow swales, gentle ridges, and low knolls dotted by a few small, deep depressions and shallow basins. Slope ranges from 0 to 6 percent.

This association makes up about 15 percent of the county. It is about 30 percent Hamerly soils, 30 percent Cresbard soils, 10 percent Svea soils, and 30 percent soils of minor extent (fig. 4).

The level to undulating, somewhat poorly drained Hamerly soils are in the shallow swales on concave toe slopes and around the margins of depressions. Typically, the surface layer is black loam about 6 inches thick. The next layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is clay loam. It is olive brown in the upper part and dark grayish brown in the lower part.

The nearly level to undulating, moderately well drained Cresbard soils are in swales on the lower foot slopes. Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is very dark gray loam about 1 inch thick. The subsoil is clay loam about 29 inches thick. In sequence downward, it is very dark grayish brown, dark grayish brown, grayish brown, and light

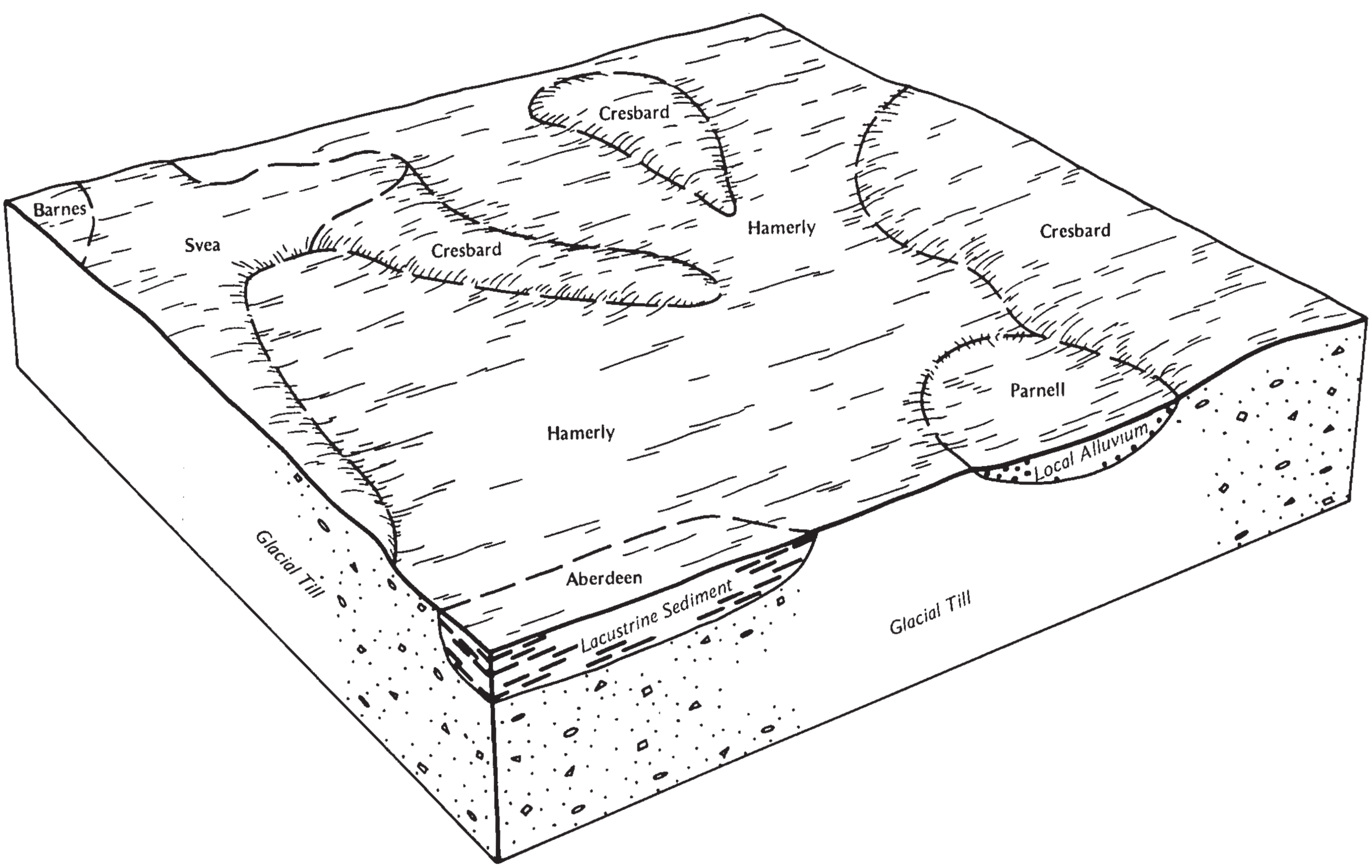


Figure 4.—Typical pattern of soils and underlying material in the Hamerly-Cresbard-Svea association.

brownish gray. The substratum to a depth of about 60 inches is grayish brown clay loam.

The nearly level to undulating, moderately well drained Svea soils are in swales on the upper foot slopes. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 32 inches thick. It is very dark grayish brown in the upper part, light yellowish brown in the next part, and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam.

Aberdeen, Barnes, Hegne, and Parnell are the minor soils in this association. The moderately well drained Aberdeen soils are in low swales and shallow basins. They are lower on the landscape than the major soils. They have a silt loam or silty clay loam surface layer and an alkali (sodic) silty clay layer in the subsoil. The well drained Barnes soils are on the side slopes and summits of ridges and knolls above the Svea soils. Their surface layer and subsoil are thinner than those of the Svea soils. The poorly drained Hegne soils are in basins. They have a silty clay surface layer. The very poorly drained Parnell soils are in deep depressions.

Most areas are used for cultivated crops. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing and maintaining good tilth are the main concerns in managing the soils for cultivated crops.

4. Bottineau Association

Deep, nearly level and undulating, well drained soils

This association is on glacial till plains. It is characterized by swales, gentle rises, and knolls dotted by a few deep depressions and low flats. Slope ranges from 1 to 6 percent.

This association makes up less than 1 percent of the county. It is about 60 percent Bottineau soils and 40 percent soils of minor extent.

Typically, the surface layer of the Bottineau soils is black loam about 9 inches thick. The subsoil is clay loam about 21 inches thick. It is black in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

Buse, Hamerly, Parnell, and Svea are the minor soils in this association. The well drained Buse soils are on the convex crests and shoulders of knolls. They have a thin and light colored surface layer. The somewhat poorly drained Hamerly soils are on toe slopes and around the margins of depressions. The very poorly drained Parnell soils are in deep depressions. The moderately well drained Svea soils are in swales on foot slopes below the Bottineau soils. Svea soils are dark to a depth of more than 16 inches.

Most areas are used for wooded pasture, but some areas have been cleared of trees and are used for cultivated crops. This association is well suited to pasture and to small grain, sunflowers, and grass-legume hay where trees have been removed. Maintaining the desired forage plants and good tilth and controlling water erosion are the main concerns in managing the soils for cultivated crops.

Dominantly Nearly Level to Hilly, Medium Textured Soils

These soils formed in glacial till and glacial outwash on till plains and outwash plains. They make up about 7 percent of the county.

These soils are used primarily as cropland, but some areas are used as pasture. The soils are generally suited to cropland. The hilly Buse soils and all of the Sioux soils, however, are best suited to pasture or range. The principal concerns in managing cropland are controlling soil blowing and water erosion. The principal concerns in managing pasture and range are maintenance of the desired plant species and proper grazing use.

5. Barnes-Buse-Svea Association

Deep, undulating to hilly, well drained and moderately well drained soils

This association is on glacial till plains and hills. It is characterized by knolls, ridges, low hills, narrow drainageways, and swales dotted by a few deep depressions. Slope ranges from 3 to 25 percent.

This association makes up about 4 percent of the county. It is about 30 percent Barnes soils, 25 percent Buse soils, 20 percent Svea soils, and 25 percent soils of minor extent.

The undulating to hilly, well drained Barnes soils are on the side slopes of the knolls, ridges, and low hills. Typically, the surface layer is black loam about 8 inches thick. The subsoil is clay loam about 34 inches thick. It is dark brown in the upper part, brown in the next part, and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam.

The undulating to rolling, well drained Buse soils are on the shoulders, crests, and summits of the knolls, ridges, and hills. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is loam about 28 inches thick. It is grayish brown in the upper part and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

The undulating, moderately well drained Svea soils are in the swales on concave foot slopes and drainageways. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Hamerly, Langhei, Parnell, and Sioux are the minor soils in this association. The somewhat poorly drained

Hamerly soils are on toe slopes adjacent to the depressions and in drainageways. They have a layer of lime accumulation within a depth of 16 inches. The well drained Langhei soils are on the crests and summits of hills. They are higher on the landscape than the Buse soils. In areas above the shores of many small lakes, they are steep and very steep. Their surface layer is thinner than that of the Buse soils. The very poorly drained Parnell soils are in the depressions. The excessively drained Sioux soils are on the summits of some knolls and ridges. They have a loam surface layer and a very gravelly sand substratum.

Most areas are used for cultivated crops, but some areas are used as pasture or hayland. The hilly areas are generally used for native grass pasture. This association is suited to small grain, sunflowers, and grass-legume hay where slopes are undulating to rolling. In hilly areas it is generally unsuited to these crops. Controlling water erosion and maintaining good tilth are the main concerns in managing the soils for cultivated crops.

6. Svea-Sioux-Buse Association

Deep, nearly level to rolling, excessively drained, well drained, and moderately well drained soils

This association is on glacial till plains and outwash plains. It is characterized by irregularly shaped knolls, ridges, swales, and narrow valleys. Slope ranges from 1 to 15 percent.

This association makes up about 3 percent of the county. It is about 27 percent Svea soils, 20 percent Sioux soils, 13 percent Buse soils, and 40 percent soils of minor extent.

The nearly level and undulating, moderately well drained Svea soils are in the swales and narrow valleys. Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The nearly level to rolling, excessively drained Sioux soils are on the crests of knolls and ridges. Typically, the surface layer is black loam about 7 inches thick. The next layer is dark grayish brown loam about 2 inches thick. The substratum to a depth of about 60 inches is brown very gravelly sand.

The undulating to rolling, well drained Buse soils are on the upper side slopes and crests of knolls and ridges. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is grayish brown loam about 28 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam.

Arvilla, Divide, Esmond, and Hamerly are the minor soils in this association. The somewhat excessively drained Arvilla soils are on nearly level ridgetops and in swales. They have a sandy loam surface layer and subsoil and are very gravelly coarse sand in the lower part of the substratum. The somewhat poorly drained Divide soils are in the valleys. They have a loam surface layer and are very gravelly sand in the upper part of the substratum. The well drained Esmond soils are on the crests and upper side slopes of knolls and ridges. They are loam in the upper part and are sandy loam and loamy sand in the lower part of the substratum. The somewhat poorly drained Hamerly soils are in areas below the Svea soils in the swales and valleys. They have a loam surface layer and a clay loam substratum.

Most areas are used for cultivated crops, but some areas are used as pasture or hayland. This association is poorly suited to small grain and sunflowers and well suited to grass-legume hay. Controlling water erosion and soil blowing and reducing the droughtiness of the Sioux soils are the main concerns in managing the soils for cultivated crops. The Arvilla, Divide, and Sioux soils are sources of gravel and sand.

Dominantly Level to Gently Sloping, Medium Textured, Moderately Fine Textured, and Fine Textured Soils

These soils formed in glacial till and lacustrine sediments. They are on glacial lake plains and transitional areas between lake plains and till plains. They make up about 16 percent of the county.

These soils are used primarily as cropland, but some areas are used as hayland, pasture, or wetland wildlife habitat. The soils are generally suited to cropland. The Colvin and Grano soils, however, are best suited to pasture. The main concerns in managing cropland are controlling soil blowing, maintaining tilth, and overcoming wetness.

7. Hamerly-Hegne-Fargo Association

Deep, level and nearly level, somewhat poorly drained and poorly drained soils

This association is on a complex landscape of glacial lake plains and till plains. It is characterized by broad, gentle swells and swales interrupted by glacial till ridges and beach areas. Complex transitional areas of soils that formed in till, lacustrine material, and outwash are between the lake plains and nearby glacial uplands. Slope ranges from 0 to 3 percent.

This association makes up about 9 percent of the county. It is about 30 percent Hamerly soils, 20 percent Hegne soils, 15 percent Fargo soils, and 35 percent soils of minor extent.

The level and nearly level, somewhat poorly drained Hamerly soils are on the till ridges and in the transitional areas. Typically, the surface layer is black loam about 6 inches thick. The next layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is olive

brown in the upper part and dark grayish brown in the lower part.

The level, poorly drained Hegne soils are on the broad, gentle swells on the lake plains. Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 37 inches thick. It is dark gray clay in the upper part and grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay.

The level, poorly drained Fargo soils are in the swales and shallow depressions on lake plains. Typically, the surface layer is black silty clay about 7 inches thick. The subsoil is about 25 inches thick. It is black clay in the upper part, very dark gray clay in the next part, and grayish brown silty clay in the lower part. The upper part of the substratum is olive gray silty clay. The lower part to a depth of about 60 inches is olive gray, mottled silty clay loam.

Aberdeen, Arvilla, Bearden, and Svea are the minor soils in this association. The moderately well drained Aberdeen soils are on swells on lake plains and in lacustrine pockets in transitional areas between the lake plains and till uplands. They have a silty clay loam or silt loam surface layer and an alkali (sodic) silty clay layer in the subsoil. The somewhat excessively drained Arvilla soils are on the beaches and in pockets of glacial outwash in transitional areas. They have a sandy loam surface layer and are very gravelly coarse sand in the lower part of the substratum. The somewhat poorly drained Bearden soils are on lake plains. They are higher on the landscape than the Fargo and Hegne soils. They contain less clay and more silt than the Fargo and Hegne soils. The moderately well drained Svea soils are on glacial till ridges on lake plains and in transitional areas. They are higher on the landscape than the Hamerly soils. They have a loam surface layer and a clay loam subsoil.

Most areas are used for cultivated crops. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing and wetness and maintaining good tilth are the main concerns in managing the soils for cultivated crops.

8. Colvin-Vallers-Aberdeen Association

Deep, level and nearly level, moderately well drained and poorly drained soils

This association is on a complex landscape of glacial lake plains and till plains. It is characterized by broad, flat plains that have gentle swells and swales and by glacial till ridges dissected by narrow drainageways and dotted by a few deep depressions. Slope ranges from 0 to 3 percent.

This association makes up about 4 percent of the county. It is about 32 percent Colvin soils, 20 percent Vallers soils, 13 percent Aberdeen soils, and 35 percent soils of minor extent.

The level, poorly drained, saline Colvin soils are in swales and drainageways. Typically, the surface soil is black silty clay loam about 11 inches thick. The subsoil is grayish brown silty clay loam about 27 inches thick. It is mottled below a depth of 24 inches. The substratum to a depth of about 60 inches is grayish brown, mottled, laminated silt loam and silty clay loam.

The level and nearly level, poorly drained, saline Vallers soils are on the till ridges, in some drainageways, and around the margins of depressions. Typically, the surface layer is black loam about 8 inches thick. The next layer is black and dark gray loam about 3 inches thick. The subsoil is mottled clay loam about 21 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive, mottled loam.

The level, moderately well drained, alkali (sodic) Aberdeen soils are on swells. Typically, the surface layer is black silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark gray and dark gray silty clay loam, very dark gray silty clay, very dark grayish brown silty clay loam, dark grayish brown silty clay loam, and grayish brown, mottled silty clay loam. The substratum to a depth of about 60 inches is mottled silty clay loam. It is light olive brown in the upper part and olive brown in the lower part.

Bearden, Cresbard, Fargo, and Parnell are the minor soils in this association. The somewhat poorly drained Bearden soils are on the swells. They are higher on the landscape than the Colvin soils. They have olive layers in the substratum. The moderately well drained, alkali (sodic) Cresbard soils are above the Vallers soils on the till ridges. They have a loam surface layer and an alkali (sodic) clay loam layer in the subsoil. The poorly drained Fargo soils are in swales below the Colvin soils. They contain more clay than the Colvin soils. The very poorly drained Parnell soils are in the deep depressions.

Most areas are used for cultivated crops, but some are used as hayland or pasture. This association is poorly suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing and wetness, controlling the salinity of the Colvin and Vallers soils, and maintaining good tilth in the Aberdeen soils are the main concerns in managing the soils for cultivated crops.

9. Hegne-Grano-Aberdeen Association

Deep, level, moderately well drained, poorly drained, and very poorly drained soils

This association is on glacial lake plains. It is characterized by low, flat basins and plains with broad, gentle swells and swales and by a few large, deep depressions. Slope is 0 to 1 percent.

This association makes up about 2 percent of the county. It is about 40 percent Hegne soils, 15 percent Grano soils, 10 percent Aberdeen soils, and 35 percent soils of minor extent.

The poorly drained, saline Hegne soils are around the margins of basins, in swales, and on swells. Typically, the surface soil is silty clay about 15 inches thick. It is black in the upper part and mottled black and very dark gray in the lower part. The subsoil is dark gray silty clay about 6 inches thick. The substratum to a depth of about 60 inches is mottled silty clay. It is dark gray and dark grayish brown in the upper part and light brownish gray in the lower part.

The very poorly drained Grano soils are in basins. Typically, the surface soil is black silty clay about 14 inches thick. The substratum to a depth of about 60 inches is mottled silty clay. It is grayish brown in the upper part and olive gray in the lower part.

The moderately well drained, alkali (sodic) Aberdeen soils are on swells. Typically, the surface layer is black silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark gray and dark gray silty clay loam, very dark gray silty clay, very dark grayish brown silty clay loam, dark grayish brown silty clay loam, and grayish brown, mottled silty clay loam. The substratum to a depth of about 60 inches is mottled silty clay loam. It is light olive brown in the upper part and olive brown in the lower part.

Colvin, Southam, and Vallers are some of the minor soils in this association. The poorly drained Colvin soils are on the swells and in some of the swales. They have less clay than the Hegne soils and commonly are saline. The very poorly drained Southam soils are in the deep depressions. The poorly drained Vallers soils are on till ridges. They have a loam surface layer and subsoil. They are saline in some areas.

Most areas are used as pasture or hayland, but some are used for cultivated crops. This association is suited to pasture and hayland. It is generally unsuited to small grain and sunflowers. Preventing surface compaction is the main concern of management if the association is grazed. Controlling wetness, salinity, and soil blowing, controlling surface ponding on the Grano soils, and maintaining good tilth in the Aberdeen soils are the main concerns in managing the soils for cultivated crops.

10. Bearden-Overly-Embden Association

Deep, level to gently sloping, moderately well drained and somewhat poorly drained soils

This association is on glacial lake plains. It is characterized by broad, gentle swells and swales and gentle rises dotted by a few beaches and deep depressions. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 45 percent Bearden soils, 11 percent Overly soils, 4 percent Embden soils, and 40 percent soils of minor extent.

The level, somewhat poorly drained Bearden soils are on the swells and in the swales. Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is very dark gray and dark gray silty clay loam about 9 inches thick. The subsoil is grayish brown, mottled silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is mottled. In sequence downward, it is light olive brown silty clay loam; olive silty clay loam; olive, gray, and yellowish brown, laminated silty clay loam and silty clay; and gray and olive, laminated silty clay loam and silty clay.

The level to gently sloping, moderately well drained Overly soils are on swells and rises above the Bearden soils. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is silty clay loam about 24 inches thick. In sequence downward, it is black; very dark grayish brown and dark brown; olive brown; and grayish brown. The substratum to a depth of about 60 inches is light olive brown, mottled silty clay loam and light olive brown, mottled silty clay.

The level and nearly level, moderately well drained Embden soils are in broad, slightly concave swales. Typically, the surface soil is loam about 19 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is fine sandy loam about 29 inches thick. It is very dark grayish brown in the upper part, dark brown and mottled in the next part, and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loamy fine sand.

Aberdeen, Arvilla, Glyndon, and Hamerly are some of the minor soils in this association. The moderately well drained Aberdeen soils are in positions on the landscape similar to those of the Overly soils. They have an alkali (sodic) silty clay layer in the subsoil. The somewhat excessively drained Arvilla soils are on beaches. They are very gravelly coarse sand in the lower part of the substratum. The somewhat poorly drained Glyndon soils are in swales near the Embden soils. They contain less sand and more silt than the Embden soils. The somewhat poorly drained Hamerly soils are on glacial till ridges. They have a loam surface layer and a clay loam substratum.

Most areas are used for cultivated crops. This association is well suited to small grain, sunflowers, and grass-legume hay. Controlling soil blowing, maintaining good tilth in the Overly soils, and conserving moisture in the Embden soils are the main concerns in managing the soils for cultivated crops.

Dominantly Level to Moderately Sloping, Moderately Fine Textured, Medium Textured, and Coarse Textured Soils

These soils formed in lacustrine sediments and glacial till on lake plains, lakeshores, and beaches. They make up about 2 percent of the county.

These soils are used primarily as range or as wetland wildlife habitat. They are suited to range, pasture, and wetland wildlife habitat. The main concerns in managing range and pasture are maintenance of the desired plant species and proper grazing use. The main concern in

managing wetland wildlife habitat is maintaining the desired water level and vegetative cover.

11. Lallie-Mauvais-Wamduska Association

Deep, level to moderately sloping, excessively drained, somewhat poorly drained, and poorly drained soils

This association is in dry lake basins characterized by broad, flat plains and beaches and water-smoothed glacial till shorelines. The flat plains are interspersed with slightly higher beaches and sandbars. Slope ranges from 0 to 9 percent.

This association makes up about 2 percent of the county. It is about 32 percent Lallie soils, 26 percent Mauvais soils, 20 percent Wamduska soils, and 22 percent soils of minor extent (fig. 5).

The level, poorly drained Lallie soils are on the broad, flat plains. Typically, the surface layer is very dark gray clay loam about 5 inches thick. The substratum extends to a depth of about 60 inches. In sequence downward, it is grayish brown silty clay; dark grayish brown and light brownish gray, laminated silty clay and clay; grayish brown, mottled, laminated silty clay and clay; and olive gray, laminated silty clay and clay.

The level to gently sloping, somewhat poorly drained Mauvais soils are on the perimeters of lake plains and on high shorelines. Typically, the surface layer is black loam about 2 inches thick. The substratum to a depth of about 60 inches is mottled loam. It is grayish brown in the upper part and dark grayish brown in the lower part.

The nearly level to moderately sloping, excessively drained Wamduska soils are on the beaches and sandbars. Typically, the surface layer is black loamy sand about 3 inches thick. The substratum extends to a depth of about 60 inches. In sequence downward, it is olive brown very gravelly sand, grayish brown very gravelly sand, light brownish gray sand, grayish brown coarse sand, grayish brown fine sand, light brownish gray very gravelly sand, and dark grayish brown sand.

Hamerly, Minnewaukan, Sioux, Svea, and Towner are the minor soils in this association. The somewhat poorly

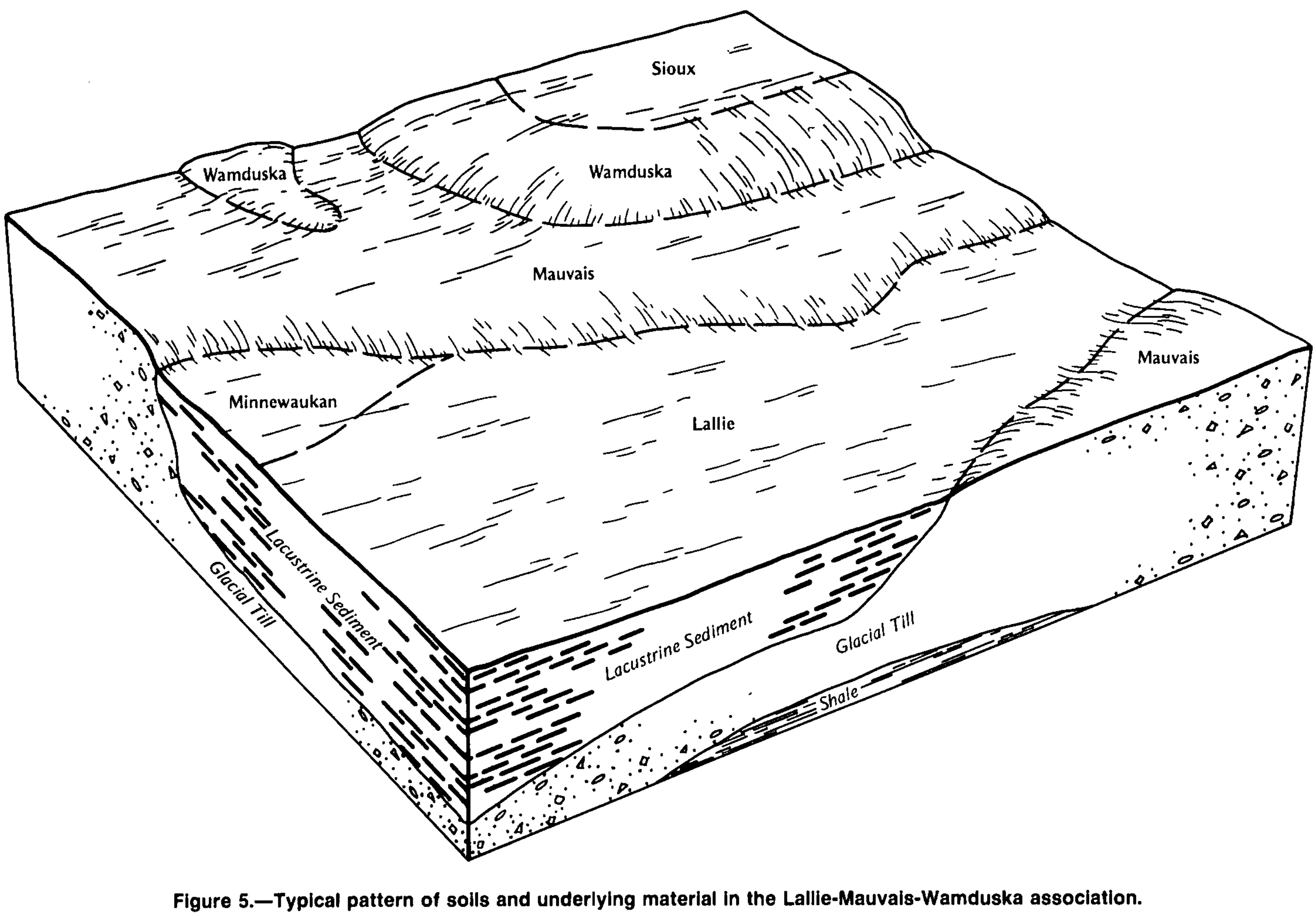


Figure 5.—Typical pattern of soils and underlying material in the Lallie-Mauvais-Wamduska association.

drained Hamerly soils are on till ridges and have a layer of lime accumulation within a depth of 16 inches. The poorly drained Minnewaukan soils are adjacent to the beaches and on nearly level sandbars. They have a loamy fine sand surface layer and a sand and fine sand substratum. The moderately well drained Svea soils are on till plains. They have a dark surface layer that is more than 16 inches thick. The excessively drained Sioux soils are near the Wamduska soils on the beaches and shorelines. They have a loam surface layer and a very gravelly sand substratum. The moderately well drained Towner soils are on sand-mantled glacial till shorelines. They have a sandy loam surface layer and a clay loam or silty clay loam substratum.

Most areas are used as hayland or range. Preventing surface compaction in grazed areas of the Lallie and Mauvais soils and conserving moisture in the Wamduska soils are the main management concerns. This association is poorly suited to small grain, sunflowers, and grass-legume hay. The Wamduska soils are generally unsuited to cultivated crops. The main concerns in managing the soils for cultivated crops are low natural fertility, soil blowing, the wetness and salinity of the Lallie soils, water erosion on the Mauvais soils, and a very low available water capacity in the Wamduska soils. The Wamduska and Sioux soils are sources of sand and gravel.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Svea loam, 1 to 3 percent slopes, is one of several phases in the Svea series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Barnes-Buse loams, 6 to 9 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils, particularly very poorly drained and poorly drained soils, are identified by a special symbol on the soil maps.

As a result of changes in series concepts, differing soil patterns, and differences in the design of map units, some of the boundaries and soil names on the Ramsey County detailed soil maps do not match those on the detailed soil maps of Benson and Walsh Counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1—Tonka silt loam. This deep, level, poorly drained soil is in shallow depressions on glacial till plains and lake plains. It is subject to ponding. Slopes are long. Individual areas range from about 3 to 70 acres.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is dark gray, mottled loam about 7 inches thick. The subsoil is about 24 inches thick. It is very dark gray, mottled silty clay loam in the upper part, dark grayish brown silty clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is mottled loam. It is grayish brown in the upper part and light olive brown in the lower part. In places the soil has no subsurface layer.

Included with this soil in mapping are small areas of the somewhat poorly drained Hamerly and poorly drained Vallers soils, which make up about 5 to 15 percent of the unit. These soils have a layer of lime accumulation within 16 inches of the surface. They surround the depressions.

Permeability is slow in the Tonka soil. Available water capacity is high, and runoff is ponded. A seasonal high water table is 0.5 foot above the surface to 1 foot below. Tilth is good.

Most areas are used for hay or wetland wildlife habitat. Some are drained and cultivated. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The wetness and the ponding are the main concerns of management. They can be controlled by surface drains, but adequate drainage outlets commonly are not available. The soil and the ponded water provide early season breeding sites and a good source of invertebrate

protein for wetland wildlife. Where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion and provides food and cover for resident and migratory wildlife. A combination of grasses and legumes for hay provides good-quality forage for livestock and nesting cover for wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increases the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 40 to 90, depending on the degree of drainage.

2—Parnell silty clay loam. This deep, level, very poorly drained soil is in depressions on glacial till plains and lake plains. It is subject to ponding. Slopes are long. Individual areas range from about 3 to 70 acres.

Typically, the surface soil is black silty clay loam about 11 inches thick. The subsoil is black silty clay about 21 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay.

Included with this soil in mapping are small areas of poorly drained Tonka and Vallers soils, which make up about 5 to 20 percent of the unit. Tonka soils have a light colored subsurface layer. Vallers soils have a layer of lime accumulation within 16 inches of the surface. They surround the depressions.

Permeability is slow in the Parnell soil. Available water capacity is high, and runoff is ponded. A seasonal high water table is 2 feet above the surface to 2 feet below. Tilth is fair.

Most areas are used for hay or wetland wildlife habitat. Some are drained and cultivated. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. It is best suited to hay, range, and wetland wildlife habitat. Surface drains can help to control the wetness and ponding, but adequate drainage outlets commonly are not available. Where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion and provides food and cover for resident and migratory wildlife. In undrained areas, crops are planted and harvested in about 2 years out of 10. The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concern in managing wildlife habitat is maintaining the natural wetness and the water level.

The key native plants in the areas managed as hayland or range are slough sedge and rivergrass. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key species helps to protect the soil and provides a plant cover for wildlife and quality forage for livestock.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation improve the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 0 to 90, depending on the degree of drainage.

4—Southam silty clay loam. This deep, level, very poorly drained soil is in deep depressions on glacial till plains and lake plains. It is subject to ponding. Slopes are long. Individual areas range from about 3 to more than 600 acres.

Typically, the surface soil is about 40 inches thick. It is black. It is silty clay loam in the upper part and mottled silty clay in the lower part. The substratum to a depth of about 60 inches is mottled silty clay. It is very dark grayish brown and dark grayish brown in the upper part, grayish brown in the next part, and dark grayish brown and light gray in the lower part. In some places the black surface soil is less than 24 inches thick. In other places it is silty clay loam throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Hamerly and poorly drained Vallers soils, which make up about 5 to 20 percent of the unit. These soils have a layer of lime accumulation within 16 inches of the surface. They surround the depressions.

Permeability is slow in the Southam soil. Available water capacity is high, and runoff is ponded. A seasonal high water table is 5 feet above the surface to 1 foot below.

Most areas are used for wildlife habitat (fig. 6). This soil is best suited to wetland wildlife habitat. It generally is unsuited to cultivated crops, trees and shrubs, and range and pasture grasses because of the ponding and the difficulty in locating suitable drainage outlets. The soil and the ponded water provide excellent winter cover for resident wildlife and high quality feeding, breeding, and

rearing sites for wetland wildlife. The main concerns in managing wildlife habitat are controlling siltation and maintaining the natural water level.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the ponding. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0.

5—Grano silty clay. This deep, level, very poorly drained soil is in basins and depressions on glacial lake plains and till plains. It is subject to rare flooding and to ponding. Slopes are long. Individual areas range from about 5 to more than 600 acres.

Typically, the surface soil is black silty clay about 14 inches thick. The substratum to a depth of about 60 inches is mottled silty clay. It is grayish brown in the upper part and olive gray in the lower part. In some places the surface layer is silty clay loam or clay. In other places the soil is slightly saline or moderately saline.

Included with this soil in mapping are small areas of the very poorly drained Parnell and poorly drained Colvin, Tonka, and Vallers soils, which make up about 5 to 20 percent of the unit. Parnell and Tonka soils have a subsoil. They are in the same landscape position as the Grano soil. Colvin and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are adjacent to the depressions.

Permeability is slow in the Grano soil. Available water capacity is high, and runoff is slow. A seasonal high water table is 1 foot above the surface to 2 feet below. Tilth is poor.

Most areas are used for hay or wetland wildlife habitat. Some areas are drained and cultivated. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. It is best suited to hay, range, and wetland wildlife habitat. Wetness, ponding, soil blowing, and the lack of suitable drainage outlets are the main management concerns if cultivated crops are grown. The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. Where this soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion and provides food and cover for migratory and resident wildlife.

The key native plants in the areas managed as hayland or range are slough sedge and rivergrass. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil. It also helps to provide a plant cover for wildlife and permits regrowth of browse plants.

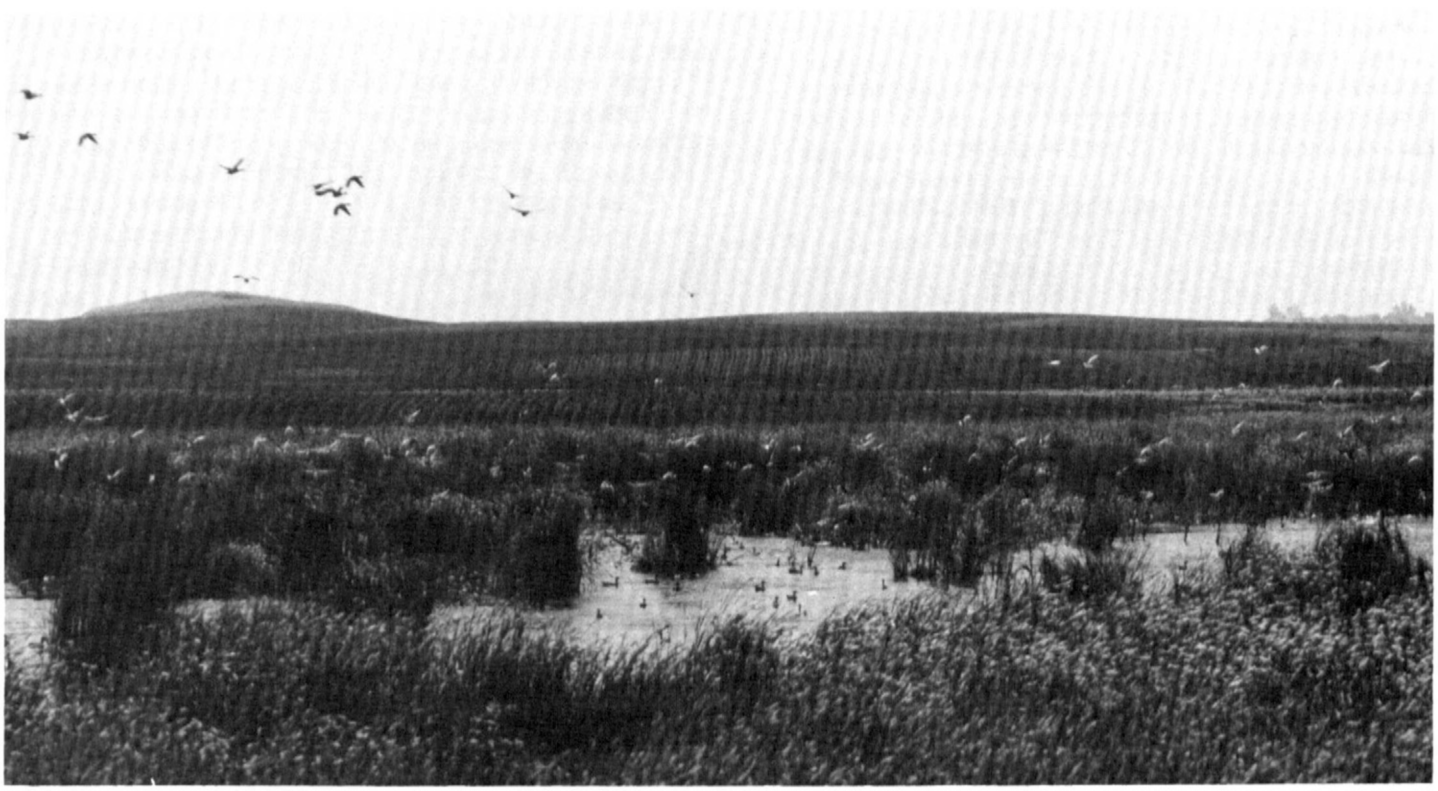


Figure 6.—An area of Southam silty clay loam used for wildlife habitat.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the ponding, the slow permeability, and the flooding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 50 to 70, depending on the degree of drainage.

7—Fargo silty clay. This deep, level, poorly drained soil is in swales on glacial lake plains. It is subject to rare flooding. Slopes are long. Individual areas range from about 5 to 70 acres.

Typically, the surface layer is black silty clay about 7 inches thick. The subsoil is about 21 inches thick. It is black and very dark gray silty clay in the upper part, very dark grayish brown, mottled silty clay in the next part, and dark grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive, mottled silty clay and silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained Aberdeen and poorly drained Hegne soils, which make up about 5 to 20 percent of the unit. Aberdeen soils have an alkali (sodic) subsoil or substratum. Hegne soils have a layer of lime accumulation within 16 inches of the surface. They are on swells.

Permeability is slow in the Fargo soil. Available water capacity is high, and runoff is slow. A seasonal high water table is within a depth of 3 feet. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of soil blowing is moderate. Maintaining good tilth, controlling soil blowing, and overcoming wetness are the main management concerns if cultivated crops are grown. Most areas are drained by coulees or drains. Installing and maintaining surface drains can reduce the wetness, but adequate drainage outlets commonly are not available. Field windbreaks and a system of conservation tillage that leaves crop residue on the surface help to control soil blowing and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to buildings, camp areas, and septic tank absorption fields. The wetness, the flooding, the shrink-swell potential, and the slow permeability are limitations. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 90.

8—Colvin silty clay loam, wet. This deep, level, very poorly drained, highly calcareous soil is in depressions on glacial lake plains and in glacial outwash channels. It is subject to ponding. Slopes are long. Individual areas range from about 5 to 50 acres.

Typically, the surface soil is black silty clay loam about 12 inches thick. The subsoil is silty clay loam about 16 inches thick. It is gray and olive gray in the upper part and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In some places the surface layer is silty clay. In other places the soil is slightly saline.

Included with this soil in mapping are small areas of the very poorly drained Grano and poorly drained Vallers soils, which make up about 5 percent of the unit. Grano soils have more clay throughout than the Colvin soil. They are in landscape positions similar to those of the Colvin soil. Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are adjacent to the depressions.

Permeability is moderately slow in the Colvin soil. Available water capacity is high, and runoff is ponded. A seasonal high water table is 1 foot above the surface to 1 foot below. Tilth is fair.

Most areas are used for hay or wetland wildlife habitat. A few are drained and cultivated. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. It is best suited to hay, range, and wetland wildlife habitat. Wetness, ponding, and the lack of suitable drainage outlets are the main management concerns if cultivated crops are grown. In some drained areas salinity has increased. The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The hazard of soil blowing is moderate. Where the soil is drained and cultivated, a system of conservation tillage that leaves crop residue on the surface helps to control erosion and provides food and cover for migratory and resident wildlife.

The key native plants in the areas managed as hayland or range are slough sedge and rivergrass. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key species helps to protect the soil. It also helps to provide a plant cover for wildlife and permits regrowth of browse plants.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 0 to 65, depending on the degree of drainage.

11—Svea-Barnes loams, 1 to 3 percent slopes. These deep, nearly level soils are on glacial till plains. The moderately well drained Svea soil is on the lower side slopes and in swales. The well drained Barnes soil is on the upper side slopes. Slope length is medium. Individual areas range from about 5 to 300 acres. They are about 45 to 70 percent Svea soil and 25 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is clay loam about 21 inches thick. In sequence downward, it is very dark brown, very dark grayish brown, dark grayish brown, and light olive brown. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the surface layer and subsoil are thinner and lighter colored. In other places the subsoil contains more clay.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 15 percent of the unit. They are lower on the landscape than the Barnes and Svea soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil.

Permeability is moderately slow in the Svea and Barnes soils. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The Svea soil is suited to all and the Barnes soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of both soils is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIc. The productivity index for spring wheat is 90.

12B—Barnes-Svea loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial till plains. The well drained Barnes soil is on the upper side slopes. The moderately well drained Svea soil is on the lower side slopes and in swales. Slope length is medium. Individual areas range from about 5 to 550 acres. They are about 45 to 65 percent Barnes soil and 25 to 45 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 9 inches thick. The subsoil is clay loam about 17 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is grayish

brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. In some places the surface layer and subsoil are thinner and lighter colored. In other places the subsoil contains more clay.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 15 percent of the unit. They are lower on the landscape than the Barnes and Svea soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions. Parnell and Tonka soils are in the depressions. They have a layer of clay accumulation in the subsoil.

Permeability is moderately slow in the Barnes and Svea soils. Available water capacity is high, and runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Barnes soil is suited to nearly all and the Svea soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of both soils is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 80.

13C—Barnes-Buse loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on moraines on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on summits and shoulder slopes. Slope length is medium. Individual areas range from about 5 to 530 acres. They are about 50 to 65 percent Barnes soil and 35 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 34 inches thick. It is dark brown in the upper part, brown in the next part, and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The subsoil is loam about 28 inches thick. It is grayish brown in the upper part and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In places the surface layer is lighter colored and thinner.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 percent of the unit. They are lower on the landscape than the Barnes and Buse soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions. Tonka and Parnell soils are in the depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Barnes and Buse soils. Available water capacity is high, and runoff is rapid. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is severe. The hazard of soil blowing is moderate on the Buse soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited only to

the most drought tolerant species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls.

The land capability classification is IIIe. The productivity index for spring wheat is 55.

13D—Barnes-Buse loams, 9 to 15 percent slopes. These deep, rolling, well drained soils are on moraines on glacial till plains. The Barnes soil is on side slopes. The Buse soil is on summits and shoulder slopes. Slope length is medium. Individual areas range from about 5 to 300 acres. They are about 45 to 60 percent Barnes soil and 35 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 18 inches thick. It is dark brown in the upper part and brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a surface layer of black loam about 7 inches thick. The subsoil is light yellowish brown loam about 7 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In places the surface layer is lighter colored and thinner.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 10 percent of the unit. They are lower on the landscape than the Barnes and Buse soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions. Tonka and Parnell soils are in the depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Barnes and Buse soils. Available water capacity is high, and runoff is rapid. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay. These soils are poorly suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is severe. The hazard of soil blowing is moderate on the Buse soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, and a cropping system that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife. A cover of hay is effective in controlling erosion. A combination of grasses and legumes helps to provide high-quality forage for livestock and nesting cover for wildlife.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. The Buse soil generally is unsuited to trees and shrubs. The trees and shrubs grown to enhance esthetic values or wildlife habitat can be planted on this soil, but special management, such as hand planting or scalp planting, is needed.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The slope is a limitation on building sites, in camp areas, and on sites for septic tank absorption fields. It can be overcome by designing buildings, camp areas, and absorption fields so that they conform to the natural slope of the land.

The land capability classification is IVe. The productivity index for spring wheat is 45.

14C—Svea-Sioux loams, 1 to 9 percent slopes. These deep, nearly level to moderately sloping soils are on glacial till plains. The moderately well drained Svea soil is on side slopes. The excessively drained Sioux soil is on summits and shoulder slopes. It is very shallow over sand and gravel. Slope length is medium. Individual areas range from about 5 to 200 acres. They are about 40 to 45 percent Svea soil and 40 to 45 percent Sioux soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface soil of black loam about 10 inches thick. The subsoil is about 37 inches thick. In sequence downward, it is very dark grayish brown loam, dark brown loam, olive brown loam, and grayish brown clay loam. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places

the dark color of the surface layer extends only to a depth of 8 to 16 inches.

Typically, the Sioux soil has a surface layer of black loam about 7 inches thick. The next layer is dark grayish brown loam about 2 inches thick. The substratum to a depth of about 60 inches is brown very gravelly sand. In places the depth to sand and gravel is as much as 20 inches. In a few places the substratum is coarse sand. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with these soils in mapping are small areas of the well drained Buse and somewhat poorly drained Hamerly soils, which make up about 5 to 20 percent of the unit. Buse soils have a surface layer that is thinner than that of the Svea and Sioux soils and have a loam and clay loam substratum. They are on the upper side slopes. Hamerly soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions.

Permeability is moderately slow in the Svea soil and very rapid in the Sioux soil. Available water capacity is high in the Svea soil and low in the Sioux soil. Runoff is medium on both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are poorly suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. The droughtiness of the Sioux soil also is a concern. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife. A cover of hay is effective in controlling erosion. A combination of grasses and legumes helps to provide high-quality forage for livestock and nesting cover for wildlife.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. The Sioux soil generally is unsuited to trees and shrubs. The trees and shrubs grown to enhance esthetic values or wildlife habitat can be planted on this soil, but special management, such as hand planting or scalp planting, is needed.

These soils are suited to buildings and camp areas. The Svea soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The moderately slow permeability of the Svea soil is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil also is a limitation. Because of the rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in pollution of ground water. A mound system helps to overcome the seasonal high water table and the rapid permeability. The shrink-swell potential of the Svea soil is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The drainage system helps also to prevent seepage into basements. In areas of the Sioux soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 55.

15C—Esmond-Emrick loams, 3 to 9 percent slopes. These deep, undulating and gently rolling soils are on glacial till plains. The well drained Esmond soil is on summits and shoulder slopes. The moderately well drained Emrick soil is on side slopes and foot slopes. Slope length is medium. Individual areas range from about 5 to 100 acres. They are about 40 to 55 percent Esmond soil and 25 to 40 percent Emrick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Esmond soil has a surface layer of black loam about 6 inches thick. The subsoil is loam about 13 inches thick. It is dark grayish brown in the upper part and pale brown in the lower part. The upper part of the substratum is light olive brown loam. The next part is light olive brown, mottled sandy loam. The lower part to a depth of about 60 inches is olive brown loamy sand. In places the subsoil is thicker.

Typically, the Emrick soil has a surface soil of black loam about 12 inches thick. The subsoil is loam about 38 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loamy sand. In places the dark color of the surface layer extends only to a depth of 8 to 16 inches. In a few places the soil contains more clay.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly and Wyrene and excessively drained Sioux soils, which make up about 10 to 25 percent of the unit. Hamerly and Wyrene soils have a layer of lime accumulation within 16 inches of the surface. They are on toe slopes. Sioux soils have a gravelly sand substratum. They are on summits and shoulder slopes.

Permeability is moderate in the Esmond and Emrick soils. Available water capacity is high, and runoff is medium. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate on both soils. The hazard of soil blowing is moderate on the Esmond soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Esmond soil is suited only to the most drought tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely. The Emrick soil is suited to all of the climatically adapted trees and shrubs. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas.

The land capability classification is IIIe. The productivity index for spring wheat is 60.

16E—Langhei-Barnes loams, 9 to 40 percent slopes. These deep, well drained soils are on moraines on glacial till plains and on slopes adjacent to drainageways. The strongly sloping to very steep Langhei soil is on summits and shoulder slopes. The strongly sloping and moderately steep Barnes soil is on side slopes. Slope length is medium. Individual areas range from about 5 to 300 acres. They are about 60 to 70 percent Langhei soil and 30 to 40 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Langhei soil has a surface layer of very dark brown loam about 4 inches thick. The subsoil is dark grayish brown loam about 19 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the surface layer is stony or gravelly. In other places it is moderately eroded and is less than 4 inches thick.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 20 inches thick. It is very dark grayish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 percent of the unit. They are lower on the landscape than the Langhei and Barnes soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are on toe slopes. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also included are some areas where the slope is more than 40 percent.

Permeability is moderate in the Langhei soil and moderately slow in the Barnes soil. Available water capacity is high in both soils, and runoff is very rapid.

Most areas are used as range. Because of the slope, a moderate hazard of soil blowing, and a severe hazard of water erosion, these soils generally are unsuited to cultivated crops and to trees and shrubs. They are best suited to range. A cover of range plants is effective in controlling erosion. The key native plants are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Prolonged overuse of the key plants reduces forage production and increases the amount of the less desirable plants and the susceptibility to erosion. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and maintains or improves plant vigor and the range condition. It also helps to provide a plant cover for rangeland wildlife and permits regrowth of browse plants.

These soils are poorly suited to buildings and septic tank absorption fields and generally are unsuited to camp areas. The moderate or moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The slope is a limitation on sites for buildings and septic tank absorption fields. It can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The shrink-swell potential of the Barnes soil is a limitation on building sites. It can be overcome by installing a foundation drainage system and by reinforcing footings and basement walls.

The land capability classification is VIIe. The productivity index for spring wheat is 0.

17D—Sioux-Buse loams, 9 to 15 percent slopes. These deep, rolling soils are on moraines and eskers on glacial till plains. The excessively drained Sioux soil is on summits and shoulder slopes. It is very shallow over sand and gravel. The well drained Buse soil is on the upper side slopes. Slope length is medium. Individual areas range from about 5 to 150 acres. They are about 40 to 55 percent Sioux soil and 35 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sioux soil has a surface layer of very dark gray loam about 7 inches thick. The next layer is dark grayish brown and light gray gravelly loam about 3

inches thick. The substratum to a depth of about 60 inches is gravelly sand. It is brown in the upper part and dark grayish brown in the lower part. In some areas the soil has a subsoil and is 9 to 20 inches deep to gravelly sand. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The subsoil is brown loam about 26 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, mottled loam. In places the surface layer is thicker and darker.

Included with these soils in mapping are small areas of the moderately well drained Svea and somewhat poorly drained Hamerly soils, which make up about 5 to 20 percent of the unit. Svea soils have a subsoil and are dark to a depth of more than 16 inches. They are on foot slopes. Hamerly soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions. Also included are some areas where the slope is more than 15 percent.

Permeability is very rapid in the Sioux soil and moderately slow in the Buse soil. Available water capacity is low in the Sioux soil and high in the Buse soil. Runoff is medium on the Sioux soil and rapid on the Buse soil.

Most areas are used as range. Some are used for cultivated crops. Because of the slope of both soils, a severe hazard of water erosion, and a moderate hazard of soil blowing on both soils, and the low available water capacity in the Sioux soil, these soils generally are unsuited to cultivated crops and to trees and shrubs. They are best suited to range. A cover of pasture or range plants is effective in controlling erosion. The key native plants are needleandthread and little bluestem. Prolonged overuse of the key plants increases the susceptibility to erosion, reduces forage production, and increases the amount of the less desirable plants. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and maintains or improves plant vigor and the range condition. It also helps to provide a plant cover for rangeland wildlife and permits regrowth of browse plants.

These soils are suited to buildings and camp areas. The Buse soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The moderately slow permeability of the Buse soil is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The Sioux soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity may result in the pollution of ground water. A mound system helps to overcome this limitation. The shrink-swell potential of the Buse soil is a limitation on building sites. It can be overcome by installing a foundation drainage system and by reinforcing footings and basement walls. The slope is a limitation on building sites, in camp areas, and on sites for septic tank absorption fields. It can be overcome by designing the buildings, camp areas, and absorption fields so that they conform to the natural slope of the land. In areas of the Sioux soil, the sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is VIs. The productivity index for spring wheat is 0.

19B—Svea-Buse loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial till plains. The moderately well drained Svea soil is on foot slopes and side slopes, and the well drained Buse soil is on summits and shoulder slopes (fig. 7). Slope length is medium. Individual areas range from about 5 to more than 600 acres. They are about 40 to 50 percent Svea soil and 40 to 50 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 9 inches thick. The subsoil is loam about 27 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In places the dark color of the surface layer extends only to a depth of 8 to 16 inches.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The subsoil is light yellowish brown clay loam about 11 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In places the surface layer is thinner and lighter colored.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly, poorly drained Tonka and Vallers, and very poorly drained Parnell soils. These included soils make up about 5 to 15 percent of the unit. They are lower on the landscape than the Svea and Buse soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They surround depressions. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Svea and Buse soils. Available water capacity is high, and runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate on both soils. The hazard of soil blowing is moderate on the Buse soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers,

Figure 7.—An area of Svea-Buse loams, 3 to 6 percent slopes. The Buse soil is in the lighter colored areas, and the Svea soil is in the darker ones.

and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. The Buse soil is suited only to the most drought tolerant, climatically adapted trees and shrubs. Optimum growth, survival, and vigor are unlikely. Removing grasses and weeds within the rows before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of both soils is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The drainage system also helps to prevent seepage into basements in the Svea soil.

The land capability classification is IIe. The productivity index for spring wheat is 70.

20—Hamerly-Svea loams, 1 to 3 percent slopes. These deep, nearly level soils are on glacial till plains. The somewhat poorly drained, highly calcareous Hamerly soil is on toe slopes. The moderately well drained Svea soil is on foot slopes. Slope length is medium. Individual areas range from about 5 to more than 600 acres. They are about 45 to 55 percent Hamerly soil and 35 to 50 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black loam about 7 inches thick. The next layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown loam in the upper part and grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is

olive, mottled clay loam. In some places the soil is poorly drained. In other places the surface layer and subsoil are silty clay loam.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is about 35 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark grayish brown loam, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the dark color of the surface layer extends only to a depth of 8 to 16 inches. In other places the surface layer and subsoil are silty clay loam.

Included with these soils in mapping are small areas of the very poorly drained Parnell and poorly drained Tonka soils, which make up about 5 to 10 percent of the unit. These included soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Hamerly and Svea soils. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is slight on both soils. The hazard of soil blowing is moderate on the Hamerly soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The drainage system also helps to prevent seepage into basements. A surface drainage system helps to overcome the wetness in camp areas. The higher parts of the landscape, where the seasonal high water table tends to be farther from the surface, are the better sites for septic tank absorption fields, buildings, and camp areas.

The land capability classification is IIe. The productivity index for spring wheat is 85.

20B—Hamerly-Svea loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial till plains. The somewhat poorly drained, highly calcareous Hamerly soil is on toe slopes. The moderately well drained Svea soil is on foot slopes. Slope length is medium. Individual areas range from about 5 to 250 acres. They are about 55 to 65 percent Hamerly soil and 25 to 30 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black loam about 7 inches thick. The subsoil is loam about 21 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the soil is poorly drained.

Typically, the Svea soil has a surface layer of black loam about 9 inches thick. The subsoil is clay loam about 27 inches thick. In sequence downward, it is black, very dark grayish brown, dark grayish brown, grayish brown, and light olive brown. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the dark color of the surface layer extends only to a depth of 8 to 16 inches.

Included with these soils in mapping are small areas of the well drained Buse, poorly drained Tonka, and very poorly drained Parnell soils, which make up about 10 to 15 percent of the unit. Buse soils are on shoulder slopes. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Hamerly and Svea soils. Available water capacity is high, and runoff is medium. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate on both soils. The hazard of soil blowing is moderate on the Hamerly soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The drainage system also helps to prevent seepage into basements. A surface drainage system helps to overcome the wetness in camp areas. The higher parts of the landscape, where the seasonal high water table tends to be farther from the surface, are the better sites for septic tank absorption fields, buildings, and camp areas.

The land capability classification is IIe. The productivity index for spring wheat is 75.

21—Vallers-Hamerly loams, saline, 0 to 3 percent slopes. These deep, level and nearly level, moderately saline, highly calcareous soils are on glacial till plains. The poorly drained Vallers soil is on the lower toe slopes. The somewhat poorly drained Hamerly soil is on the upper toe slopes. Some areas are dissected by meandering channels. Slope length is medium. Individual areas range from about 5 to more than 600 acres. They are about 35 to 60 percent Vallers soil and 25 to 45 percent Hamerly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Vallers soil has a surface layer of black loam about 8 inches thick. The next layer is black and dark gray loam about 3 inches thick. The subsoil is mottled clay loam about 21 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive, mottled loam.

Typically, the Hamerly soil has a surface soil of black loam about 15 inches thick. The subsoil is light yellowish brown loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the soil is only slightly saline.

Included with these soils in mapping are small areas of the moderately well drained Cresbard and Svea, poorly drained Tonka, and very poorly drained Parnell soils, which make up about 10 to 20 percent of the unit. Cresbard and Svea soils are on foot slopes. Cresbard soils have an alkali (sodic) layer. Svea soils are dark to a depth of more than 16 inches. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Vallers and Hamerly soils. Available water capacity is moderate, and runoff is slow. A seasonal high water table is within a depth of 1 foot in the Vallers soil and is at a depth of 2 to 4 feet in the Hamerly soil. Tilth is good in both soils. The high content of salts restricts plant growth.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is slight. The hazard of soil blowing is moderate. Wetness, salinity, and erosion are the main management concerns if cultivated crops are grown. Installing and maintaining surface drains can reduce the wetness, but suitable drainage outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and salinity. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Because of the salinity, salt-tolerant crops should be selected for planting, summer fallow should be avoided, and shallow tillage is needed.

These soils are suited to only a few of the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor because the amount of available water is reduced by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. Drying of the bare surface tends to move salt-laden water to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and thus protect seedlings from abrasion.

These soils are generally unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness, the moderately slow permeability, and the salinity. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 50.

22—Vallers loam. This deep, level, poorly drained, highly calcareous soil is on toe slopes on glacial till plains. Slope length is medium. Individual areas range from about 5 to 120 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 12 inches thick. It is gray. It is clay loam in the upper part and mottled loam in the lower part. The substratum to a depth of about 60 inches is mottled. In sequence downward, it is grayish brown loam, grayish brown clay loam, and dark grayish

brown clay loam. In some places the soil is somewhat poorly drained, and in a few places it is slightly saline or moderately saline.

Included with this soil in mapping are small areas of the poorly drained Tonka and very poorly drained Parnell soils, which make up about 5 to 20 percent of the unit. These soils are in depressions.

Permeability is moderately slow in the Vallers soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of soil blowing is moderate. Reducing the wetness, controlling soil blowing, and maintaining good tilth are the main management concerns if cultivated crops are grown. Surface drains can reduce the wetness, but suitable drainage outlets commonly are not available. In some drained areas salinity has increased. Field windbreaks, annual crop barriers, and a system of conservation tillage that leaves crop residue on the surface help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness and the moderately slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 70.

23—Hamerly-Cresbard loams, 1 to 3 percent slopes. These deep, nearly level soils are on glacial till plains. The somewhat poorly drained, highly calcareous Hamerly soil is on the lower toe slopes. The moderately well drained, alkali (sodic) Cresbard soil is on the upper toe slopes. Slope length is medium. Individual areas range from about 5 to more than 600 acres. They are about 45 to 55 percent Hamerly soil and 40 to 50 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black loam about 6 inches thick. The next layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is olive brown in the upper part and dark grayish brown in the lower part. In places the soil is poorly drained.

Typically, the Cresbard soil has a surface layer of black loam about 6 inches thick. The subsurface layer is very dark gray loam about 1 inch thick. The subsoil is clay loam about 29 inches thick. In sequence downward, it is very dark grayish brown, dark grayish brown, grayish brown, and light brownish gray. The substratum to a depth of about 60 inches is grayish brown clay loam. In places the surface layer is silt loam.

Included with these soils in mapping are small areas of the moderately well drained Svea soils, the poorly drained Tonka soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 10 percent of the unit. Svea soils do not have an alkali (sodic) layer. They are in the same landscape position as the Cresbard soil. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Hamerly soil and slow in the Cresbard soil. Available water capacity is high in the Hamerly soil and moderate in the Cresbard soil. Runoff is slow on both soils. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil. Tilth is good in the Hamerly soil. The surface of the Cresbard soil is hard and crusted when dry and dispersed when wet. The compact subsoil of the Cresbard soil restricts the rooting of plants.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is slight on both soils. The hazard of soil blowing is moderate on the Hamerly soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The Hamerly soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. The Cresbard soil is suited to many of the climatically adapted trees and shrubs. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Individual trees and shrubs grown on the Cresbard soil vary in height, density, and vigor because the compact subsoil restricts root development and the available water capacity is reduced by the salts in the

soil. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability of the Hamerly soil and the slow permeability of the Cresbard soil are limitations on sites for septic tank absorption fields. They can be overcome by enlarging the absorption field. The seasonal high water table in the Hamerly soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of both soils is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. A drainage system also helps to prevent seepage into basements and reduces the wetness of campsites in areas of the Hamerly soil.

The land capability classification is IIe. The productivity index for spring wheat is 80.

24—Svea-Cresbard loams, 1 to 3 percent slopes. These deep, nearly level, moderately well drained soils are on glacial till plains. The Svea soil is on the upper foot slopes. The alkali (sodic) Cresbard soil is on the lower foot slopes. Slope length is medium. Individual areas range from about 5 to 170 acres in size. They are about 40 to 55 percent Svea soil and 35 to 45 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a surface layer of black loam about 8 inches thick. The subsoil is loam about 32 inches thick. It is very dark grayish brown in the upper part, light yellowish brown in the next part, and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In places the dark color of the surface layer extends only to a depth of 8 to 16 inches.

Typically, the Cresbard soil has a surface layer of black loam about 6 inches thick. The subsurface layer is very dark gray loam about 1 inch thick. The subsoil is clay loam about 29 inches thick. In sequence downward, it is very dark grayish brown, dark grayish brown, grayish brown, and light brownish gray. The substratum to a depth of about 60 inches is grayish brown clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 20 percent of the unit. They are lower on the landscape than the Cresbard and Svea soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are on toe slopes. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Svea soil and slow in the Cresbard soil. Available water capacity is high in the Svea soil and moderate in the Cresbard soil. Runoff is slow on both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in the Svea soil. The surface of the Cresbard soil is hard and crusted when dry and dispersed when wet. The compact subsoil of the Cresbard soil restricts the rooting of plants.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. The Cresbard soil is suited to many of the climatically adapted trees and shrubs. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Individual trees and shrubs grown on the Cresbard soil vary in height, density, and vigor because the compact subsoil restricts root development and the available water capacity is reduced by the salts in the soil.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability of the Svea soil and the slow permeability of the Cresbard soil are limitations on sites for septic tank absorption fields. They can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of both soils is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls. The drainage system also helps to prevent seepage into basements in the Svea soil.

The land capability classification is IIs. The productivity index for spring wheat is 80.

24B—Barnes-Cresbard loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial till plains. The well drained Barnes soil is on the upper side slopes. The moderately well drained, alkali (sodic) Cresbard soil is on the lower side slopes. Slope length is medium. Individual areas range from about 5 to 120 acres. They are about 50 to 65 percent Barnes soil and 30 to 40 percent Cresbard soil. The two soils occur as

areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a surface layer of black loam about 9 inches thick. The subsoil is clay loam about 17 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is grayish brown in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. In some places the surface layer and subsoil are thinner and lighter colored. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Cresbard soil has a surface layer of black loam about 6 inches thick. The subsoil is about 29 inches thick. In sequence downward, it is very dark grayish brown clay loam, very dark gray clay, dark brown clay loam, and light olive brown loam. The substratum to a depth of about 60 inches is light olive brown clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils, the poorly drained Tonka and Vallers soils, and the very poorly drained Parnell soils. These included soils make up about 5 to 15 percent of the unit. They are lower on the landscape than the Barnes and Cresbard soils. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are on toe slopes. Parnell and Tonka soils are in depressions. They have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Barnes soil and slow in the Cresbard soil. Available water capacity is high in the Barnes soil and moderate in the Cresbard soil. Runoff is medium on both soils. Tilth is good in the Barnes soil. The surface of the Cresbard soil is hard and crusted when dry and dispersed when wet. The compact subsoil of the Cresbard soil restricts the rooting of plants.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many of the climatically adapted trees and shrubs. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Individual trees and shrubs grown on the Cresbard soil vary in height, density, and vigor because the compact subsoil restricts root development and the available water capacity is reduced by the salts in the soil.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability of the Barnes soil and the slow permeability of the Cresbard soil are limitations on sites for septic tank absorption fields. They can be overcome by enlarging the absorption field. The shrink-swell potential of both soils is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls.

The land capability classification is IIIe. The productivity index for spring wheat is 75.

26—Vallers-Parnell-Tonka complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on glacial till plains. The poorly drained, nearly level, highly calcareous Vallers soil surrounds depressions. The very poorly drained, level Parnell soil is in deep depressions. The poorly drained, level Tonka soil is in shallow depressions. The Tonka and Parnell soils are commonly ponded. Slopes are short. Individual areas range from about 5 to 200 acres. They are about 50 to 60 percent Vallers soil, 15 to 35 percent Parnell soil, and 10 to 25 percent Tonka soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Vallers soil has a surface soil of black loam about 22 inches thick. The next layer is dark gray, mottled clay loam about 9 inches thick. The subsoil is olive gray loam about 10 inches thick. The substratum to a depth of about 60 inches is olive, mottled clay loam. In some places the soil is moderately saline. In other places it is somewhat poorly drained.

Typically, the Parnell soil has a surface soil of black silty clay loam about 11 inches thick. The subsoil is black silty clay about 21 inches thick. The substratum to a depth of about 60 inches is olive gray and mottled. It is silty clay in the upper part and laminated silty clay and silty clay loam in the lower part.

Typically, the Tonka soil has a surface layer of black silt loam about 9 inches thick. The subsurface layer is dark gray, mottled loam about 7 inches thick. The subsoil is about 24 inches thick. It is very dark gray, mottled silty clay loam in the upper part, dark grayish brown silty clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is mottled loam. It is grayish brown in the upper part and light olive brown in the lower part.

Included with these soils in mapping are small areas of the moderately well drained Svea and poorly drained Ojata soils, which make up about 5 percent of the unit. Svea soils are dark to a depth of more than 16 inches.

They are on the lower foot slopes. Ojata soils are strongly saline. They are in the same landscape position as the Vallers soil.

Permeability is moderately slow in the Vallers soil and slow in the Parnell and Tonka soils. Available water capacity is high in all three soils. Runoff is slow on the Vallers soil and ponded on the Parnell and Tonka soils. A seasonal high water table is at a depth of 1.0 to 2.5 feet in the Vallers soil, is 2.0 feet above to 2.0 feet below the surface of the Parnell soil, and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Tilth is good in the Tonka and Vallers soils and fair in the Parnell soil.

Most areas are used for cultivated crops, hay, or wetland wildlife habitat. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. Wetness, however, is a limitation. The hazard of soil blowing is moderate on the Vallers soil. The hazard of water erosion is slight on all three soils. Wetness and soil blowing are the main management concerns if cultivated crops are grown. A surface drainage system can reduce the wetness, but suitable drainage outlets commonly are not available. In some drained areas salinity has increased. In undrained areas crops are planted and harvested in about 2 years out of 10 on the Parnell soil and in about 5 to 7 years out of 10 on the Tonka soil. Crops are planted and harvested in most years on the Vallers soil. A conservation tillage system that leaves crop residue on the surface helps to control soil blowing. It also helps to provide food and cover for resident and migratory wildlife.

The Tonka and Parnell soils and the ponded water provide breeding sites and a source of high-quality invertebrate protein for wetland wildlife. The main concern in managing wildlife habitat is maintaining the natural wetness and the water level.

If drained, these soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on these soils is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness and the ponding. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 50 to 80, depending on the degree of drainage.

28C—Zell-Maddock complex, 3 to 9 percent slopes. These deep, undulating and gently rolling, well drained soils are on kames, eskers, and moraines on glacial till plains. Slope length is medium. Individual areas range from about 5 to 70 acres. They are about 25 to 60 percent Zell soil and 15 to 60 percent Maddock soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zell soil has a surface layer of black loam about 6 inches thick. The subsoil is silt loam about 10 inches thick. It is very dark grayish brown in the upper part and olive brown in the lower part. The substratum to a depth of about 60 inches is olive brown. It is silt loam in the upper part and laminated silt loam and very fine sandy loam in the lower part. In some places the surface layer is thin and moderately eroded. In other places the surface layer and subsoil are thicker and darker.

Typically, the Maddock soil has a surface layer of very dark gray fine sandy loam about 7 inches thick. The next layer is dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is fine sand. It is dark brown in the upper part and dark grayish brown and mottled in the lower part. In places the surface layer is thinner and eroded.

Included with these soils in mapping are small areas of the moderately well drained Embden soils, the well drained Esmond soils, and the excessively drained Sioux soils. These included soils make up about 10 to 30 percent of the unit. Embden soils have a subsoil and are in swales. Esmond and Sioux are on summits and shoulder slopes. Esmond soils have a sandy substratum. Sioux soils have a very gravelly sand substratum. Also included are some areas where the slope is more than 9 percent.

Permeability is moderate in the Zell soil and rapid in the Maddock soil. Available water capacity is high in the Zell soil and low in the Maddock soil. Runoff is medium on both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is severe. The hazard of soil blowing is severe on the Maddock soil and moderate on the Zell soil. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Zell soil is suited only to the most drought tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely. The Maddock soil is suited to many of the climatically adapted trees and

shrubs. It is somewhat droughty, however, and moisture stress is common, particularly during periods when the trees and shrubs are becoming established. Irrigation or other means of providing supplemental water during the establishment period help to ensure survival of seedlings. Little benefit is derived from fallowing the Maddock soil the season prior to planting because of the limited available water capacity. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to buildings and camp areas. The Zell soil is suited to septic tank absorption fields, but the Maddock soil is poorly suited. The moderate permeability of the Zell soil is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. Because of the rapid permeability, the Maddock soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to overcome this limitation. In areas of the Maddock soil, the sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 45.

30—Embden loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is in swales on glacial lake plains. Slopes are long. Individual areas range from about 5 to 70 acres.

Typically, the surface soil is loam about 19 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is fine sandy loam about 29 inches thick. It is very dark grayish brown in the upper part, dark brown and mottled in the next part, and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loamy fine sand. In places the soil is silt loam throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Glyndon and Wyrene and moderately well drained Overly soils, which make up about 15 to 30 percent of the unit. Glyndon and Wyrene soils have a layer of lime accumulation within 16 inches of the surface. They are lower on the landscape than the Embden soil. Overly soils contain more silt and clay throughout than the Embden soil. They are in the same landscape position as the Embden soil.

Permeability is moderately rapid in the Embden soil. Available water capacity is moderate, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings (fig. 8). No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. The seasonal high water table also is a limitation on sites for buildings with basements. It can be overcome by installing a surface and foundation drainage system. The sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIe. The productivity index for spring wheat is 80.

31—Svea loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on broad flats on glacial till plains smoothed by water action. Slopes are long. Individual areas range from about 5 to 320 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark brown loam, very dark grayish brown loam, very dark grayish brown gravelly loam, and grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In some places the substratum has a thin gravelly layer. In other places the dark color of the surface layer extends only to a depth of 8 to 16 inches.

Included with this soil in mapping are small areas of the poorly drained Vallers soils, the somewhat poorly drained Hamerly soils, and the moderately well drained Cresbard soils. These included soils make up about 15 to 25 percent of the unit. Hamerly and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are on toe slopes below the Svea soils. Cresbard soils have an alkali (sodic) layer. They are in landscape positions similar to those of the Svea soil.

Permeability is moderately slow in the Svea soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-

Figure 8.—A multirow windbreak in an area of Embden loam, 0 to 3 percent slopes.

legume hay. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption

field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIc. The productivity index for spring wheat is 90.

32—Glyndon silt loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is in swales on glacial lake plains. Slopes are long. Individual areas range from about 5 to 130 acres.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsoil is silt loam about 22 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown and mottled. It is silt loam in the upper part and silty clay loam in the lower part. In places the soil contains more clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Hamerly and moderately well drained Aberdeen and Embden soils, which make up about 10 to 25 percent of the unit. Hamerly soils have a loam surface layer and substratum. They are in the same landscape position as the Glyndon soil. Embden soils lack a layer of lime accumulation within 16 inches of the surface. They are on low rises and ridges above the Glyndon soil. Aberdeen soils have an alkali (sodic) layer. They are higher on the landscape than the Glyndon soil.

Permeability is moderately rapid in the Glyndon soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The seasonal high water table is a limitation on sites for septic tank absorption fields. A mound system helps to overcome this limitation. The seasonal high water table also is a limitation on sites for buildings with basements. It can be overcome by installing a surface and foundation drainage system.

The land capability classification is IIe. The productivity index for spring wheat is 95.

34—Aberdeen silt loam. This deep, level, moderately well drained, alkali (sodic) soil is on broad swells on glacial lake plains. Slopes are long. Individual areas range from about 5 to 230 acres.

Typically, the surface layer is black silt loam about 7 inches thick. The subsoil is about 24 inches thick. In sequence downward, it is very dark gray silty clay loam, very dark grayish brown silty clay, dark grayish brown silty clay loam, and grayish brown silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. It is light olive brown and mottled in the upper part and grayish brown and light olive brown in the lower part.

Included with this soil in mapping are small areas of the somewhat poorly drained Bearden soils, the poorly drained Colvin and Hegne soils, and the moderately well drained Overly soils. These included soils make up about 10 to 30 percent of the unit. They do not have an alkali (sodic) layer. Bearden, Colvin, and Hegne soils have a layer of lime accumulation within 16 inches of the surface. Bearden and Overly soils are on swells, and Colvin and Hegne soils are in swales.

Permeability is slow in the Aberdeen soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. The surface is hard and crusted when dry and dispersed when wet. The compact subsoil restricts the rooting of plants.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Individual trees and shrubs grown on this soil vary in

height, density, and vigor because the compact subsoil restricts root development and the available water capacity is reduced by the salts in the soil.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIIs. The productivity index for spring wheat is 80.

35—Overly silty clay loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is in broad swales on glacial lake plains. Slopes are long. Individual areas range from about 5 to 220 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is silty clay loam about 24 inches thick. In sequence downward, it is black; dark brown and very dark grayish brown; olive brown; and grayish brown. The substratum to a depth of about 60 inches is light olive brown and mottled. It is silty clay loam in the upper part and silty clay in the lower part. In places the soil contains less clay.

Included with this soil in mapping are small areas of the moderately well drained Aberdeen and somewhat poorly drained Bearden and Hamerly soils, which make up about 10 to 30 percent of the unit. Aberdeen soils are in landscape positions similar to those of the Overly soil. They have an alkali (sodic) layer. Bearden and Hamerly soils have a layer of lime accumulation within 16 inches of the surface. They are lower on the landscape than the Overly soil.

Permeability is moderately slow in the Overly soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls.

The land capability classification is IIc. The productivity index for spring wheat is 95.

36—Bearden silty clay loam. This deep, level, somewhat poorly drained, highly calcareous soil is on broad swells on glacial lake plains. Slopes are long. Individual areas range from about 5 to 350 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The next layer is very dark gray and dark gray silty clay loam about 9 inches thick. The subsoil is grayish brown, mottled silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is mottled. In sequence downward, it is light olive brown silty clay loam; olive silty clay loam; olive, gray, and yellowish brown, laminated silty clay loam and silty clay; and gray and olive, laminated silty clay and silty clay loam. In some places the soil is poorly drained. In other places the lower part of the substratum is loam.

Included with this soil in mapping are small areas of the moderately well drained Aberdeen and Overly and poorly drained Hegne soils, which make up about 5 to 25 percent of the unit. Aberdeen soils have an alkali (sodic) layer. Overly soils have a silty clay loam subsoil. Aberdeen and Overly soils are on swells above the Bearden soil. Hegne soils contain more clay than the Bearden soil. They are in landscape positions similar to those of the Bearden soil.

Permeability is moderately slow in the Bearden soil. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is fair.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. A drainage system also helps to prevent seepage into basements and reduces the wetness of campsites.

The land capability classification is IIe. The productivity index for spring wheat is 90.

38—Colvin silty clay loam, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is in shallow depressions on glacial lake plains and in glacial outwash channels. Many areas are dissected by meandering channels. The soil is occasionally flooded. Slopes are long. Individual areas range from about 5 to 360 acres.

Typically, the surface soil is black silty clay loam about 11 inches thick. The subsoil is grayish brown, mottled silty clay loam about 27 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, laminated silty clay loam and silt loam. In some places the soil is somewhat poorly drained. In other places it contains more clay.

Included with this soil in mapping are small areas of the moderately well drained Aberdeen and poorly drained Hegne soils, which make up about 5 to 10 percent of the unit. Aberdeen soils have an alkali (sodic) layer. They are on swells above the Colvin soil. Hegne soils contain more clay than the Colvin soil. They are in landscape positions similar to those of the Colvin soil.

Permeability is moderately slow in the Colvin soil. Available water capacity is moderate, and runoff is slow. A seasonal high water table is within a depth of 2 feet. Tilth is fair. The high content of salts restricts plant growth.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Maintaining good tilth, reducing wetness, and controlling erosion are the main management concerns if cultivated crops are grown. A surface drainage system can reduce the wetness, but suitable outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Because of the salinity, salt-tolerant crops should be selected for planting and summer fallow should be avoided.

This soil is suited to only a few of the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor because the amount of available water is reduced by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. Drying of the bare surface tends to move salt-laden water to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the moderately slow permeability and the wetness. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 45.

39—Colvin silty clay loam. This deep, level, poorly drained, highly calcareous soil is in swales on glacial lake plains. Slopes are long. Individual areas range from about 5 to 230 acres.

Typically, the surface soil is black silty clay loam about 11 inches thick. The subsoil is silty clay loam about 19 inches thick. It is gray in the upper part and light brownish gray in the lower part. The substratum to a depth of about 60 inches is mottled. It is olive brown silty clay loam in the upper part, yellowish brown silty clay loam in the next part, and dark grayish brown silty clay in the lower part. In some places the soil is somewhat poorly drained. In other places it contains more clay.

Included with this soil in mapping are small areas of the moderately well drained Aberdeen soils, the poorly drained Fargo soils, and the very poorly drained Grano soils. These soils make up about 5 to 25 percent of the unit. Aberdeen soils have an alkali (sodic) layer. They are higher on the landscape than the Colvin soil. Fargo and Grano soils contain more clay than the Colvin soil. Also, they are lower on the landscape.

Permeability is moderately slow in the Colvin soil. Available water capacity is high, and runoff is slow. A seasonal high water table is within a depth of 1 foot. Tilth is fair.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and

the hazard of soil blowing is moderate. Maintaining good tilth, controlling wetness, and controlling erosion are the main management concerns if cultivated crops are grown. A surface drainage system can reduce the wetness, but suitable outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the moderately slow permeability and the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 50 to 70, depending on the degree of drainage.

40—Colvin-Aberdeen silty clay loams. These deep, level soils are on glacial lake plains. The poorly drained, highly calcareous, moderately saline Colvin soil is in swales. It is occasionally flooded. The moderately well drained, alkali (sodic) Aberdeen soil is on swells. Slopes are long. Individual areas range from 5 to about 200 acres. They are about 45 to 55 percent Colvin soil and 40 to 55 percent Aberdeen soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Colvin soil has a surface layer of black silty clay loam about 7 inches thick. The subsoil is silty clay loam about 23 inches thick. It is dark gray in the upper part and olive gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive, mottled silty clay loam. In places the soil is somewhat poorly drained and contains less clay.

Typically, the Aberdeen soil has a surface layer of black silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark gray and dark gray silty clay loam, very dark gray silty clay, very dark grayish brown silty clay loam, dark grayish brown silty clay loam, and grayish brown, mottled silty clay loam. The substratum to a depth of about 60 inches is mottled silty clay loam. It is light olive brown in the upper part and olive brown in the lower part.

Included with these soils in mapping are small areas of the somewhat poorly drained Bearden and Hamerly soils, which make up about 5 percent of the unit. These included soils have a layer of lime accumulation within 16 inches of the surface and are on swells.

Permeability is moderately slow in the Colvin soil and slow in the Aberdeen soil. Available water capacity is moderate in both soils. Runoff is slow. A seasonal high water table is within a depth of 2 feet in the Colvin soil and at a depth of 4 to 6 feet in the Aberdeen soil. Tilth is fair in the Colvin soil. The surface of the Aberdeen soil is hard and crusted when dry and dispersed when wet. The compact subsoil of the Aberdeen soil restricts the rooting of plants. The content of salts in the Colvin soil restricts plant growth.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is slight. The hazard of soil blowing is moderate on the Colvin soil. Salinity, wetness, and erosion are the main management concerns if cultivated crops are grown. A surface drainage system can reduce the wetness, but suitable outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Because of the salinity, salt-tolerant crops should be selected for planting and summer fallow should be avoided.

The Colvin soil is suited to only a few of the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Aberdeen soil is suited to many of the climatically adapted trees and shrubs. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Individual trees and shrubs grown on these soils vary in height, density, and vigor because the compact subsoil of the Aberdeen soil restricts root development and because the available water capacity in both soils is reduced by the content of salts. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness, the flooding, and the slow permeability. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 65.

42—Fargo-Hegne silty clays. These deep, level, poorly drained soils are on glacial lake plains. The Fargo

soil is in swales. The highly calcareous Hegne soil is on swells. Both soils are subject to rare flooding. Slopes are long. Individual areas range from about 5 to more than 600 acres. They are about 45 to 60 percent Fargo soil and 40 to 55 percent Hegne soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Fargo soil has a surface layer of black silty clay about 7 inches thick. The subsoil is about 25 inches thick. It is black clay in the upper part, very dark gray clay in the next part, and grayish brown silty clay in the lower part. The upper part of the substratum is olive gray silty clay. The lower part to a depth of about 60 inches is olive gray, mottled silty clay loam. In places the substratum is clay loam.

Typically, the Hegne soil has a surface layer of black silty clay about 8 inches thick. The subsoil is about 37 inches thick. It is dark gray clay in the upper part and grayish brown, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay. In some places the soil contains less clay. In other places the substratum is clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Bearden and Hamerly soils, which make up about 5 percent of the unit. These included soils have a layer of lime accumulation within 16 inches of the surface. Also, they contain less clay than the Fargo and Hegne soils. They are on swells.

Permeability is slow in the Fargo soil and very slow in the Hegne soil. Available water capacity is high in both soils, and runoff is slow. A seasonal high water table is within a depth of 3.0 feet in the Fargo soil and at a depth of 1.0 to 2.5 feet in the Hegne soil. Tilth is poor in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, oats, flax, barley, and grass-legume hay. The hazard of water erosion is slight. The hazard of soil blowing is moderate. Maintaining good tilth, controlling wetness, and controlling erosion are the main management concerns if cultivated crops are grown. Most areas are drained by coulees or drains, but adequate drainage outlets are commonly not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

If drained, these soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on these soils is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields, buildings, and camp areas because of the slow or very slow permeability, the flooding, and the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 85.

44—Hegne silty clay, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is on swells on glacial lake plains. It is subject to rare flooding. Slopes are long. Individual areas range from about 5 to 600 acres.

Typically, the surface soil is silty clay about 15 inches thick. It is black in the upper part and mottled black and very dark gray in the lower part. The subsoil is dark gray silty clay about 6 inches thick. The substratum to a depth of about 60 inches is mottled silty clay. It is dark gray and dark grayish brown in the upper part and light brownish gray in the lower part. In places the soil is slightly saline or strongly saline.

Included with this soil in mapping are small areas of the very poorly drained Grano soils, which make up about 5 percent of the unit. These soils are in depressions and swales below the Hegne soil.

Permeability is very slow in the Hegne soil. Available water capacity is moderate, and runoff is slow to ponded. A seasonal high water table is 1.0 foot above the surface to 2.5 feet below. Tilth is poor. The high content of salts restricts plant growth.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Salinity, wetness, and erosion are the main management concerns if cultivated crops are grown. Surface drains can reduce the wetness, but suitable drainage outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Because of the salinity, salt-tolerant crops should be selected for planting and summer fallow should be avoided.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor because the amount of available water is reduced by the salts in the soil. Reducing the evaporation rate at the surface im-

proves seedling survival. Drying of the bare surface tends to move salt-laden water to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the very slow permeability, the flooding, and the wetness. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 55.

45—Hegne silty clay. This deep, level, poorly drained, highly calcareous soil is on swells on glacial lake plains. It is subject to rare flooding. Slopes are long. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is black silty clay about 8 inches thick. The subsoil is about 37 inches thick. It is dark gray clay in the upper part and grayish brown, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay. In places the soil is slightly saline.

Included with this soil in mapping are small areas of the poorly drained Fargo and very poorly drained Grano soils, which make up about 5 to 20 percent of the unit. Fargo soils are in swales below the Hegne soil. Grano soils are in depressions.

Permeability is very slow in the Hegne soil. Available water capacity is moderate, and runoff is slow. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Tilth is poor.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight. The hazard of soil blowing is moderate. Maintaining good tilth, controlling wetness, and controlling erosion are the main management concerns if cultivated crops are grown. Surface drains can reduce the wetness, but suitable drainage outlets commonly are not available. In some drained areas salinity has increased. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness, the flooding, and the very slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 75.

46—Aberdeen-Fargo silty clay loams. These deep, level soils are on glacial lake plains. The moderately well drained, alkali (sodic) Aberdeen soil is on swells. The poorly drained Fargo soil is in swales. Slopes are long. Individual areas range from about 5 to 250 acres. They are about 40 to 50 percent Aberdeen soil and 30 to 50 percent Fargo soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Aberdeen soil has a surface layer of black silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. In sequence downward, it is very dark gray and dark gray silty clay loam, very dark gray silty clay, very dark grayish brown silty clay loam, dark grayish brown silty clay loam, and grayish brown, mottled silty clay loam. The substratum to a depth of about 60 inches is mottled silty clay loam. It is light olive brown in the upper part and olive brown in the lower part.

Typically, the Fargo soil has a surface layer of black silty clay loam about 7 inches thick. The subsoil is about 21 inches thick. It is black and very dark gray silty clay in the upper part, very dark grayish brown, mottled silty clay in the next part, and dark grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is olive, mottled, laminated silty clay and silty clay loam.

Included with these soils in mapping are small areas of the poorly drained Colvin, Hegne, and Vallers and moderately well drained Overly soils. These included soils make up about 10 to 25 percent of the unit. They do not have an alkali (sodic) layer. Colvin, Hegne, and Vallers soils have a layer of lime accumulation within 16 inches of the surface. They are on swells between the Fargo and Aberdeen soils. Overly soils are on low rises or ridges above the Aberdeen soil.

Permeability is slow in the Aberdeen and Fargo soils. Available water capacity is high, and runoff is slow. A seasonal high water table is at a depth of 4 to 6 feet in the Aberdeen soil and within a depth of 3 feet in the Fargo soil. Tilth is fair in the Fargo soil. The surface of the Aberdeen soil is hard and crusted when dry and dispersed when wet. The compact subsoil of the Aberdeen soil restricts the rooting of plants.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Controlling wetness in the Fargo soil, maintaining good tilth, and controlling erosion are the

main management concerns if cultivated crops are grown. Surface drains can reduce the wetness in the Fargo soil, but suitable drainage outlets commonly are not available. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The Aberdeen soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs grown on this soil vary in height, density, and vigor because the compact subsoil restricts root development and available water capacity is reduced by the content of salts. If drained, the Fargo soil is suited to all of the climatically adapted trees and shrubs. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

The Aberdeen soil is suited to septic tank absorption fields, buildings, and camp areas. The Fargo soil is generally not used for these purposes. The slow permeability and wetness of the Aberdeen soil are limitations on sites for septic tank absorption fields. They can be overcome by installing a mound system. The shrink-swell potential is a problem on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls.

The land capability classification is IIw. The productivity index for spring wheat is 85.

50B—Towner sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is in swales on glacial till plains and lake plains. Slope length is medium. Individual areas range from about 5 to 200 acres.

Typically, the surface soil is about 23 inches thick. It is black. It is sandy loam in the upper part and mottled, loamy sand in the lower part. The substratum to a depth of about 60 inches is mottled. It is dark grayish brown clay loam in the upper part, grayish brown silty clay loam in the next part, and light olive brown clay loam in the lower part. In some places the surface layer is thinner and eroded. In other places the surface layer and the upper part of the substratum are loamy coarse sand.

Included with this soil in mapping are small areas of stony soils and well drained soils, which make up about 5 percent of the unit. The well drained soils are on low rises and ridges.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. Available water capacity is moderate, and runoff is slow. A seasonal high water table is at a depth of 3 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Droughtiness and erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion, conserve moisture, and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, however, and moisture stress is common, particularly during periods when the trees and shrubs are becoming established. Irrigation or other means of providing supplemental water during the establishment period help to ensure survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the limited available water capacity. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a limitation on sites for buildings with basements. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements. The sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 60.

52—Wyrene sandy loam, loamy substratum, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is in broad swales on glacial lake plains. Slope length is medium. Individual areas range from about 5 to 120 acres.

Typically, the surface soil is black sandy loam about 10 inches thick. The subsoil is dark grayish brown sandy loam about 8 inches thick. The substratum to a depth of

about 60 inches is mottled. It is pale brown loamy sand in the upper part, light brownish gray gravelly sand in the next part, and gray, laminated loam and clay loam in the lower part. In some places the slope is more than 3 percent. In other places the soil is slightly saline. In a few places the lower part of the substratum is gravelly sand. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with this soil in mapping are small areas of the excessively drained Sioux soils, the somewhat excessively drained Arvilla soils, and the somewhat poorly drained Hamerly soils. These soils make up about 5 to 20 percent of the unit. Sioux and Arvilla soils have a higher content of gravel than the Wyrene soil. Also, they are higher on the landscape. Hamerly soils contain more silt and clay than the Wyrene soil. They are in the same landscape position as the Wyrene soil.

Permeability is rapid in the upper part of the Wyrene soil and moderately slow in the lower part. Available water capacity is moderate, and runoff is slow. A seasonal high water table is at a depth of 3 to 5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Controlling erosion is the main management concern if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields, buildings, and camp areas. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in pollution of ground water. The seasonal high water table also is a limitation. A mound system helps to overcome the seasonal high water table and the rapid permeability. The wetness is a limitation on sites for buildings with basements. It can be overcome by installing a surface and foundation drainage system. The sides of shallow excavations, such as those for basements walls, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 55.

53—Renshaw loam, 1 to 3 percent slopes. This deep, nearly level, somewhat excessively drained soil is on gentle swells on glacial outwash plains. It is shallow over sand and gravel. Slopes are long. Individual areas range from about 5 to 250 acres.

Typically, the surface layer is black loam about 6 inches thick. The subsoil is about 18 inches thick. In sequence downward, it is very dark grayish brown loam, dark brown loam, dark yellowish brown sandy loam, and brown gravelly sand. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sand. In places the soil is excessively drained. In the northeastern part of the survey area, the sand and gravel are mainly shale particles. In some areas, the soil is dark to a depth of more than 16 inches and the depth to sand and gravel is more than 20 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Divide soils, which make up about 5 to 15 percent of the unit. These soils have a layer of lime accumulation within 16 inches of the surface. They are in swales.

Permeability is moderate in the upper part of the Renshaw soil and rapid in the lower part. Available water capacity is low, and runoff is slow. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Droughtiness and erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion, conserve moisture, and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, however, and moisture stress is common. Irrigation or other means of providing supplemental water help to ensure survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the limited available water capacity. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to buildings and camp areas and poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to overcome this limitation. The sides of shallow excavations,

such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 45.

54B—Arvilla sandy loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat excessively drained soil is on gentle swells on glacial outwash plains. It is shallow over sand and gravel. Slope length is medium. Individual areas range from about 5 to 150 acres.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is very dark brown sandy loam about 6 inches thick. The upper part of the substratum is dark brown gravelly coarse sand. The lower part to a depth of about 60 inches is brown very gravelly coarse sand. In places the surface layer is loam. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with this soil in mapping are small areas of the moderately well drained Svea and somewhat poorly drained Wyrene and Divide soils, which make up about 10 to 25 percent of the unit. Svea soils have a loam or clay loam substratum. They are on slight rises and ridges. Wyrene and Divide soils have a layer of lime accumulation within 16 inches of the surface. They are in swales.

Permeability is rapid in the Arvilla soil. Available water capacity is low, and runoff is slow. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is severe. Droughtiness and erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion, conserve moisture, and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, however, and moisture stress is common. Irrigation or other means of providing supplemental water help to ensure survival of seedlings. Little benefit is derived from fallowing the season prior to planting because of the limited available water capacity. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to buildings and camp areas and poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in pollution of ground water. A mound system helps to overcome this limitation. The sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 45.

56—Hamerly-Renshaw loams, 0 to 3 percent slopes. These deep, level and nearly level soils are on a complex landscape of intermixed glacial till plains and outwash plains. The somewhat poorly drained, highly calcareous Hamerly soil is in swales. The somewhat excessively drained Renshaw soil is on swells. It is shallow over sand and gravel. Slope length is medium. Individual areas range from about 5 to 350 acres. They are about 45 to 90 percent Hamerly soil and 10 to 25 percent Renshaw soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a surface layer of black loam about 6 inches thick. The next layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is mottled clay loam. It is olive brown in the upper part and dark grayish brown in the lower part. In some places the soil is poorly drained. In other places it contains more clay. In some areas the substratum is gravelly sand.

Typically, the Renshaw soil has a surface layer of black loam about 6 inches thick. The subsoil is about 18 inches thick. In sequence downward, it is very dark grayish brown loam, dark brown loam, dark yellowish brown sandy loam, and brown gravelly sand. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sand. In some places the soil is excessively drained or moderately well drained. In other places the substratum is not gravelly. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with these soils in mapping are small areas of the well drained Barnes soils, the moderately well drained Cresbard soils, and the poorly drained Fargo soils. These included soils make up about 5 to 30 percent of the unit. Barnes soils have a substratum of clay loam that is not mottled. They are on swells. Cresbard soils have an alkali (sodic) layer. They are higher on the landscape than the Hamerly soil. Fargo soils contain more clay than the Hamerly and Renshaw soils. They are in swales below the Hamerly soil.

Permeability is moderately slow in the Hamerly soil. It is moderate in the upper part of the Renshaw soil and rapid in the lower part. Available water capacity is high in the Hamerly soil and low in the Renshaw soil. Runoff is slow on both soils. A seasonal high water table is at a

depth of 2 to 4 feet in the Hamerly soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is slight. The hazard of soil blowing is moderate on the Hamerly soil. Reducing the droughtiness of the Renshaw soil and controlling erosion on both soils are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion, conserve moisture, and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

The Hamerly soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. The Renshaw soil is suited to some of the climatically adapted trees and shrubs. It is droughty, however, and moisture stress is common. Irrigation or other means of providing supplemental water help to ensure survival of seedlings. Little benefit is derived from fallowing the Renshaw soil the season prior to planting because of the limited available water capacity. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

These soils are suited to buildings and camp areas. The Hamerly soil is suited to septic tank absorption fields, but the Renshaw soil is poorly suited. The moderately slow permeability of the Hamerly soil is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. Because of the rapid permeability, the Renshaw soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in pollution of ground water. A mound system helps to overcome this limitation.

The shrink-swell potential of the Hamerly soil is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. A drainage system also helps to prevent seepage into basements and reduces the wetness of campsites in areas of the Hamerly soil. In areas of the Renshaw soil, the sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIe. The productivity index for spring wheat is 70.

57C—Sioux loam, 1 to 9 percent slopes. This deep, nearly level to moderately sloping, excessively drained soil is on summits and shoulder slopes on glacial outwash plains and till plains. It is very shallow over sand and gravel. Slope length is medium. Individual areas range from about 5 to 50 acres.

Typically, the surface layer is black loam about 7 inches thick. The next layer is dark grayish brown loam about 2 inches thick. The substratum to a depth of about 60 inches is brown very gravelly sand. In places, the surface layer is more than 7 inches thick and the depth to sand and gravel is as much as 20 inches. In a few places the substratum is coarse sand. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with this soil in mapping are small areas of the somewhat excessively drained Renshaw soils and the somewhat poorly drained Wyrene and Divide soils. These soils make up about 5 to 25 percent of the unit. Renshaw soils are deeper over sand and gravel than the Sioux soil. Also, they are lower on the landscape. Wyrene and Divide soils have a layer of lime accumulation within 16 inches of the surface. They are in swales.

Permeability is very rapid in the Sioux soil. Available water capacity is low, and surface runoff is slow.

Most areas are used for hay or pasture. Because of the low available water capacity and low natural fertility, this soil generally is unsuited to cultivated crops and to trees and shrubs. It is best suited to range. A cover of range or pasture plants is effective in controlling erosion. The key native plant is needleandthread. Prolonged overuse of the key species reduces forage production and increases the susceptibility to erosion and the number of less desirable plants. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key species helps to protect the soil and maintains or improves plant vigor and the range condition. It also helps to provide a plant cover for rangeland wildlife and permits regrowth of browse plants.

This soil is suited to buildings and camp areas and is poorly suited to septic tank absorption fields. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to overcome this limitation. The sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is VIs. The productivity index for spring wheat is 0.

58—Divide loam, loamy substratum, 1 to 3 percent slopes. This deep, nearly level, somewhat poorly drained, highly calcareous soil is in swales on glacial outwash plains. Slopes are long. Individual areas range from about 5 to 100 acres.

Typically, the surface soil is black loam about 11 inches thick. The subsoil is loam about 17 inches thick. It

is dark gray in the upper part and grayish brown in the lower part. The upper part of the substratum is yellowish brown very gravelly sand. The lower part to a depth of about 60 inches is olive, mottled clay loam. In places the lower part of the substratum is silt loam, silty clay, or very gravelly sand. In the northeastern part of the survey area, the sand and gravel are mainly shale particles.

Included with this soil in mapping are small areas of the somewhat poorly drained Hamerly soils and the somewhat excessively drained Arvilla and Renshaw soils. These soils make up about 15 to 30 percent of the unit. Hamerly soils have a loam substratum. They are in landscape positions similar to those of the Divide soil. Renshaw and Arvilla soils are better drained than the Divide soil. They are on swells. Also included are some gently sloping areas.

Permeability is moderate in the upper part of the Divide soil, rapid in the next part, and moderately slow in the lower part. Available water capacity is moderate, and runoff is slow. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect survival or growth. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is suited to buildings and camp areas and is poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in contamination of ground water. The seasonal high water table also is a limitation. A mound system helps to overcome the seasonal high water table and the rapid permeability. The wetness is a limitation on sites for buildings with basements. Installing a surface and foundation drainage system helps to prevent seepage into basements. The sides of shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 60.

65—Ojata clay loam. This deep, level, poorly drained, highly calcareous, strongly saline soil is in swales on glacial till plains and lake plains. Slopes are long. Individual areas range from about 5 to 500 acres.

Typically, the surface layer is black, mottled clay loam about 4 inches thick. The next layer is dark gray, mottled clay loam about 5 inches thick. The subsoil is grayish brown, mottled clay loam about 21 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In places the soil is slightly saline or moderately saline.

Included with this soil in mapping are small areas of the poorly drained Hegne and Vallers soils and the very poorly drained Parnell and Southam soils. These soils make up about 5 to 10 percent of the unit. Hegne and Vallers soils are in the same landscape position as the Ojata soil. Hegne soils have a silty clay surface layer. Vallers soils have a loam surface layer. Parnell and Southam soils are in deep depressions.

Permeability is slow in the Ojata soil. Available water capacity is low, and runoff is very slow. A seasonal high water table is within a depth of 1 foot. The high content of salts restricts plant growth.

Most areas are used for hay, pasture, or range. Because of the wetness, the salinity, and the hazard of soil blowing, this soil generally is unsuited to cultivated crops and to trees and shrubs. It is best suited to range or wetland wildlife habitat. A cover of range or pasture plants is effective in controlling erosion. The key native plant is western wheatgrass. Prolonged overuse of the key species reduces forage production and increases the susceptibility to soil blowing and the amount of less desirable plants. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key species helps to protect the soil and maintains or improves plant vigor and the range condition. This system is especially needed when the soil is wet. The soil and the ponded water provide breeding sites and a source of invertebrate protein for wetland wildlife. The main concern in managing wildlife habitat is maintaining the natural wetness.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness and the slow permeability. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0.

70—Lallie clay loam. This deep, level, poorly drained soil is on broad flats on lake plains. It is frequently flooded. Slopes are long. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is very dark gray clay loam about 5 inches thick. The substratum extends to a depth

of about 60 inches. In sequence downward, it is grayish brown, mottled silty clay; dark grayish brown and light brownish gray, laminated silty clay and clay; grayish brown, mottled, laminated silty clay and clay; and olive gray, laminated silty clay and clay. In some places the soil is slightly saline or moderately saline. In other places it is very poorly drained. In some areas the surface layer is sandy loam, loam, or silty clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Mauvais soils, the excessively drained Wamduska soils, and the poorly drained Minnewaukan soils. These soils make up about 5 to 20 percent of the unit. Mauvais soils are better drained than the Lallie soil. Also, they are in slightly higher landscape positions. Wamduska soils have a loamy sand surface layer. They are on beaches. Minnewaukan soils have a loamy fine sand surface layer. They are on sandbars.

Permeability is slow in the Lallie soil. Available water capacity is high, and runoff is very slow. A seasonal high water table is within a depth of 1 foot. Tilth is poor.

Most areas are used for hay or range. This soil is poorly suited to wheat, sunflowers, barley, flax, and grass-legume hay. Wetness, soil blowing, and low natural fertility are the main management concerns if cultivated crops are grown. Adequate drainage outlets commonly are not available. In some drained areas salinity has increased. Surface drains can help to control the wetness. Annual crop barriers and a system of conservation tillage that leaves crop residue on the surface help to control soil blowing. Where the soil is drained and cultivated, conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife. Applying the proper kinds and amounts of fertilizer and growing legumes improve fertility.

A cover of pasture or range plants is effective in controlling erosion. The key native plants are slim sedge, wooly sedge, fescue sedge, and prairie cordgrass. Prolonged overuse of the key plants reduces forage production and increases the amount of less desirable plants and the susceptibility to erosion. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and maintains or improves plant vigor and the range condition. This system is especially needed when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the flooding, the wetness, the slow permeability, and the shrink-swell potential. Better sites generally are nearby.

The land capability classification is IVw. The productivity index for spring wheat is 25.

75—Lallie clay loam, saline. This deep, level, poorly drained, moderately saline soil is on broad flats on lake plains. It is frequently flooded and is subject to ponding. Slopes are long. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is very dark gray clay loam about 5 inches thick. The substratum extends to a depth of about 60 inches. In sequence downward, it is grayish brown, mottled silty clay; dark grayish brown and light brownish gray, laminated silty clay and clay; grayish brown, mottled, laminated silty clay and clay; and olive gray, laminated silty clay and clay. In some places the soil is slightly saline or strongly saline. In other places it is very poorly drained. In some areas the surface layer is sandy loam, loam, or silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Mauvais soils, the excessively drained Wamduska soils, and the poorly drained Minnewaukan soils. These soils make up about 5 to 15 percent of the unit. Mauvais soils are better drained than the Lallie soil. Also, they are in slightly higher landscape positions. Wamduska soils have a loamy sand surface layer. They are on beaches. Minnewaukan soils have a loamy fine sand surface layer. They are on sandbars.

Permeability is slow in the Lallie soil. Available water capacity is moderate, and runoff is slow. A seasonal high water table is 1 foot above the surface to 1 foot below. The high content of salts restricts plant growth.

Most areas are used for hay or range. Because of the wetness, the ponding, the hazard of soil blowing, and the salinity, this soil generally is unsuited to cultivated crops and to trees and shrubs. It is best suited to range and wetland wildlife habitat. A cover of range plants is effective in controlling erosion. The key native plant is western wheatgrass. Prolonged overuse of the key plant species reduces forage production and increases the susceptibility to soil blowing and the amount of less desirable plants. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key species helps to protect the soil and maintains or improves plant vigor and the range condition. This system is especially needed when the soil is wet. The soil and the ponded water provide breeding sites and a source of invertebrate protein for wetland wildlife. The main concern in managing wildlife habitat is maintaining the natural water level.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the flooding, the slow permeability, the ponding, and the shrink-swell potential. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0.

77—Minnewaukan loamy fine sand, 1 to 3 percent slopes. This deep, nearly level, poorly drained soil is on beaches and sandbars on lake plains. Slope length is medium. Individual areas range from about 5 to 70 acres.

Typically, the surface layer is very dark brown loamy fine sand about 4 inches thick. The substratum to a depth of about 60 inches is mottled. In sequence downward, it is grayish brown sand, dark grayish brown sand, grayish brown fine sand, dark grayish brown fine sand, and grayish brown sand. In places the surface layer and substratum are fine sandy loam or loamy sand. In a few places the soil is slightly saline or moderately saline.

Included with this soil in mapping are small areas of the excessively drained Wamduska soils, the somewhat poorly drained Mauvais soils, and the poorly drained Lallie soils. These soils make up about 5 to 20 percent of the unit. Wamduska soils contain more gravel in the substratum than the Minnewaukan soil. Also, they are on higher beaches. Mauvais soils have a loam surface layer and a clay loam substratum. They are on old shorelines. Lallie soils have a clay loam surface layer and a silty clay substratum. They are below the beaches and sandbars on the lake plains. Also included are a few small gently sloping areas.

Permeability is rapid in the Minnewaukan soil. Available water capacity is low, and runoff is slow. A seasonal high water table is within a depth of 2.5 feet. Tilth is good.

Most areas are used for range. This soil is poorly suited to wheat, sunflowers, barley, flax, and grass-legume hay. Wetness and a severe hazard of soil blowing are the main management concerns if cultivated crops are grown. Adequate drainage outlets commonly are not available. Surface drains can help to control the wetness. Field windbreaks, annual crop barriers, and a system of conservation tillage that leaves crop residue on the surface help to control soil blowing. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

A cover of pasture or range plants is effective in controlling erosion. The key native plants are big bluestem and switchgrass. Prolonged overuse of the key species reduces forage production and increases the susceptibility to soil blowing and the amount of less desirable plants. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and improves or maintains plant vigor and the range condition. This system is especially needed when the soil is wet. It helps to provide a plant cover for rangeland wildlife and permits regrowth of browse plants.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, generally are unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The cover of grasses and weeds that grows on this soil is abundant and persistent. Removing this cover within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields, buildings, and camp areas because of the wetness. Better sites generally are nearby.

The land capability classification is IVs. The productivity index for spring wheat is 25.

78C—Wamduska loamy sand, 1 to 9 percent slopes. This deep, level to moderately sloping, excessively drained soil is on beaches and sandbars on lake plains. Slopes are short. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is black loamy sand about 3 inches thick. The substratum extends to a depth of about 60 inches. In sequence downward, it is olive brown very gravelly sand, grayish brown very gravelly sand, light brownish gray sand, grayish brown coarse sand, grayish brown fine sand, light brownish gray very gravelly sand, and dark grayish brown sand. In some places the substratum is dark grayish brown loam or sandy loam. In other places the surface is stony.

Included with this soil in mapping are small areas of the somewhat poorly drained Mauvais and poorly drained Minnewaukan and Lallie soils, which make up about 5 to 10 percent of the unit. These soils are lower on the landscape than the Wamduska soil.

Permeability is rapid in the Wamduska soil. Available water capacity is very low, and runoff is slow. The amount of gravel is small, but the soil is a source of gravel.

Most areas are used as range. Because of the very low available water capacity, low natural fertility, and a severe hazard of soil blowing, this soil generally is unsuited to cultivated crops and to trees and shrubs. It is best suited to range. A cover of pasture or range plants is effective in controlling erosion. The key native plants are needleandthread and prairie sandreed. Prolonged overuse of the key plants increases the susceptibility to soil blowing and the amount of less desirable plants and decreases forage production. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and maintains or improves plant vigor and the range condition. It also helps to maintain a plant cover for rangeland wildlife and permits regrowth of browse plants.

This soil is suited to buildings and camp areas and is poorly suited to septic tank absorption fields. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. A mound system helps to overcome this limitation. The sides of

shallow excavations, such as those for basement walls, tend to cave in unless they are shored.

The land capability classification is VIIs. The productivity index for spring wheat is 0.

81B—Mauvais loam, 0 to 6 percent slopes. This deep, level to gently sloping, somewhat poorly drained soil is on shorelines on lake plains. Slope length is medium. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is black loam about 2 inches thick. The substratum to a depth of about 60 inches is mottled loam. It is grayish brown in the upper part and dark grayish brown in the lower part. In some places the surface is stony. In other places the soil is slightly saline or moderately saline. In some areas the substratum is loam or silty clay.

Included with this soil in mapping are small areas of the excessively drained Wamduska and poorly drained Lallie and Minnewaukan soils, which make up about 10 to 25 percent of the unit. Wamduska soils have a loamy sand surface layer, and Minnewaukan soils have a loamy fine sand surface layer. Both of these soils are on beaches and sandbars. Lallie soils are poorly drained. They are lower on the landscape than the the Mauvais soil. Also included are some moderately sloping areas.

Permeability is moderately slow in the Mauvais soil. Available water capacity is high, and runoff is medium. A seasonal high water table is at a depth of 1 to 4 feet. Tilth is fair.

Most areas are used as range. This soil is poorly suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is slight, and the hazard of soil blowing is moderate. Low natural fertility, soil blowing, and water erosion are the main management concerns if cultivated crops are grown. Applying the proper amounts and kinds of fertilizer and growing legumes improve fertility. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and water erosion. Conservation tillage and buffer strips help to provide food and nesting cover for resident and migratory wildlife.

A cover of pasture or range plants is effective in controlling erosion. The key native plants are western wheatgrass and needleandthread. Prolonged overuse of the key species increases the susceptibility to erosion, decreases forage production, and reduces the infiltration rate and the extent of protective surface mulch. A system of alternate grazing and deferment that leaves about 50 percent of the annual growth of the key plants helps to protect the soil and maintains or improves plant vigor and the range condition. It also helps to maintain a nesting cover for rangeland wildlife and permits regrowth of browse plants.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing weeds and grasses within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows help to control soil blowing and thus protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the field. The seasonal high water table also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential is a problem on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls. The drainage system also helps to prevent seepage into basements. A surface drainage system reduces the wetness in camp areas.

The land capability classification is IVw. The productivity index for spring wheat is 30.

83B—Great Bend-Overly silty clay loams, 3 to 6 percent slopes. These deep, undulating soils are on glacial lake plains. The well drained Great Bend soil is on swells. The moderately well drained Overly soil is in swales. Slope length is medium. Individual areas range from about 5 to 90 acres. They are about 55 to 70 percent Great Bend soil and 20 to 35 percent Overly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Great Bend soil has a surface soil about 10 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is about 36 inches thick. It is very dark grayish brown silt loam in the upper part, light olive brown silt loam in the next part, and light olive brown, laminated silt loam and silty clay loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, laminated silt loam and silty clay loam.

Typically, the Overly soil has a surface soil of black silty clay loam about 10 inches thick. The subsoil is silty clay loam about 25 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Bearden soils, the well drained Zell soils, and the moderately well drained Aberdeen soils. These included soils make up about 5 to 25 percent of the unit. Bearden soils have a layer of lime accumulation within 16 inches of the surface. They are in swales below the Overly soil. Zell soils are on knolls. They contain less clay than the Great Bend and Overly soils and have a thinner surface layer. Aberdeen soils have an alkali (sodic) layer. They are in the same landscape position as the Overly soil.

Permeability is moderate in the Great Bend soil and moderately slow in the Overly soil. Available water capacity is high in both soils, and runoff is medium. A seasonal high water table is at a depth of 4 to 6 feet in the Overly soil. Tilth is fair in both soils.

Most areas are used for cultivated crops. These soils are suited to wheat, sunflowers, flax, barley, and grass-legume hay. The hazard of water erosion is moderate. The hazard of soil blowing is slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

The Great Bend soil is suited to nearly all and the Overly soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability of the Overly soil and the moderate permeability of the Great Bend soil are limitations on sites for septic tank absorption fields. They can be overcome by enlarging the absorption field. The seasonal high water table in the Overly soil also is a limitation. A mound system helps to overcome this limitation. The shrink-swell potential of the Overly soil is a limitation on building sites. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and foundation walls.

The land capability classification is IIe. The productivity index for spring wheat is 80.

84—Bottineau loam, 1 to 3 percent slopes. This deep, nearly level, well drained soil is on glacial till plains. Slope length is medium. Individual areas range from about 5 to more than 600 acres.

Typically, the surface soil is about 10 inches thick. It is black. It is loam in the upper part and clay loam in the lower part. The subsoil is clay loam about 40 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the very poorly drained Parnell and poorly drained Tonka soils, which make up about 5 to 15 percent of the unit. These soils are in depressions. Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Bottineau soil. Available water capacity is high, and runoff is slow. Tilth is good.

Most areas are used as wooded pasture. Some have been cleared and are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazards of water erosion and soil blowing are slight. Maintaining good tilth and controlling erosion are the main management concerns if cultivated crops are grown. A system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage also helps to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls.

The land capability classification is IIc. The productivity index for spring wheat is 90.

84B—Bottineau loam, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on glacial till plains. Slope length is medium. Individual areas range from about 5 to more than 600 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is clay loam about 21 inches thick. It is black in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The substratum to a depth of about 60 inches is grayish brown clay loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the very poorly drained Parnell and poorly drained Tonka soils, which make up about 5 to 10 percent of the unit. These soils are in depressions. Tonka soils have a light colored subsurface layer. Also included are some areas where the slope is more than 6 percent.

Permeability is moderately slow in the Bottineau soil. Available water capacity is high, and runoff is medium. Tilth is good.

Most areas are used as wooded pasture. Some have been cleared and are used for cultivated crops. This soil is suited to wheat, sunflowers, barley, flax, and grass-legume hay. The hazard of water erosion is moderate, and the hazard of soil blowing is slight. Maintaining good

tilth and controlling erosion are the main management concerns if cultivated crops are grown. Grassed waterways in areas where runoff concentrates, a system of conservation tillage that leaves crop residue on the surface, annual crop barriers, and a cropping sequence that includes grass-legume hay help to control erosion and maintain or improve tilth. Conservation tillage and grassed waterways also help to provide food and nesting cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Removing grasses and weeds within the row before the trees and shrubs are planted and then controlling regrowth of the competing vegetation increase the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields, buildings, and camp areas. The moderately slow permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation on sites for buildings. It can be overcome by installing a surface and foundation drainage system and by reinforcing footings and basement walls.

The land capability classification is IIe. The productivity index for spring wheat is 85.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 220,000 acres in the survey area, or nearly 40 percent of the total acreage, meets the soil requirements for prime farmland. Nearly all of this prime farmland is used for crops. The crops grown on this land, mainly wheat and sunflowers, account for a major part of the county's total agricultural income each year.

A recent trend in land use in some parts of the country has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that have limitations, such as a seasonal high water table, frequent flooding during the growing season, or inadequate rainfall, qualify for prime farmland only in areas where these limitations have been overcome by such measures as drainage, flood control, or irrigation. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Prepared by Lyle J. Samson, agronomist, and Merle Huhner, district conservationist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 83 percent of Ramsey County is cultivated. Historically, small grain has been the dominant crop. It still is grown on most of the cropland, but recent years have been characterized by a greater variety of crops.

In 1980, about 385,700 acres was used for small grain and flax; 77,100 acres for row crops, principally sunflowers; and 18,500 acres for forage crops. About 160,000 acres was summer fallowed.

Shifts from row crops to close-grown crops vary from year to year, depending on market conditions. The trend is toward less summer fallow. Ten years ago, one-third of the cropland commonly was fallowed. This percentage has declined to about one-fourth because of an increase in applications of nitrogen fertilizer, a series of wetter than average years, improved crop varieties, and a wider choice of herbicides for weed control.

The principal close-grown crops in 1980 were as follows: spring wheat, 76,000 acres; durum wheat, 240,000 acres; barley, 56,000 acres; oats, 2,500 acres; and flax, 10,900 acres. The principal row crops were sunflowers, 74,000 acres; corn for silage, 1,000 acres; and dry edible beans, 2,100 acres. The forage crops were alfalfa, 4,000 acres, and other hay crops, 14,500 acres. A small acreage was planted to mustard, rapeseed, rye, safflower, buckwheat, lentils, potatoes, and millet.

The potential of the soils in Ramsey County for increased production of food and fiber is good. The production is steadily increasing as improved crop production technology is applied. This soil survey can facilitate the application of this technology. The soils and climate of the county are suited to most of the crops that are commonly grown in the county and to some that are not commonly grown.

The principal management measures needed to ensure continuing productivity are those that control soil blowing and water erosion, maintain fertility and tilth, and result in proper utilization of soil moisture. Also, soils in which the degree of salinity can be a problem, such as

Hamerly and Vallers soils (fig. 9), should be managed in such a way that salts remain dispersed throughout the profile. Cropping year after year, eliminating summer fallow, and growing grasses and legumes for hay help to control salinity. If the surface is bare when the soil is dry, salt-laden water tends to move to the surface, increasing the degree of salinity.

Soil blowing and water erosion reduce the productivity of soils. If the surface layer is lost, available plant nutrients are also lost. As a result, applications of fertilizer are needed to maintain crop production. The added cost reduces the net return from the land.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on most of the soils of Ramsey County. The hazard is most severe on coarse textured and moderately coarse textured soils, such as Arvilla, Maddock, Minnewaukan, and Wyrene.

Bearden, Buse, Colvin, Divide, Esmond, Glyndon, Hamerly, Hegne, Langhei, Mauvais, Ojata, Vallers, Wyrene, Zell, and other soils that have a relatively high content of lime are susceptible to soil blowing, particularly in the spring, if they have been bare of vegetation throughout winter. Because of freezing and thawing, soil structure breaks down, resulting in an increased susceptibility to soil blowing.

Water erosion is a particular hazard on moderately sloping and steeper soils, such as Barnes, Buse, Esmond, Langhei, Maddock, and Zell. The hazard is most severe when the surface is not protected by a cover of plants or crop residue.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover on the surface. Examples are conservation tillage systems that leave crop residue on the surface. Applications of herbicide can help to minimize the need for tillage. Field shelterbelts, cover crops, annual crop barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping sequence, grassed waterways (fig. 10), and diversions help to control water erosion. A combination of several measures is generally needed to protect the soil.

Figure 9.—An area of Vallers-Hamerly loams, saline, 0 to 3 percent slopes. Salinity restricts crop growth and the choice of crops. The degree of salinity is indicated by the extent to which the soil is bare or covered by kochia, a common weed.

Figure 10.—An area eroded by concentrations of runoff. A grassed waterway in this area would help to control gully erosion.

The county has a considerable acreage of low lying, level and nearly level soils. These soils are highly productive if the surface is free of ponded water during the growing season. The area of these soils extends from east of Sweetwater and Morrison Lakes westerly through the Dry Lake area and to Lake Irvine and the low land generally east and southeast of Churchs Ferry. Much of the spring meltwater flowing into this area inundates the low, level and nearly level cropland. Because the water moves off very slowly, the soil is saturated and seeding is delayed. Flooding and ponding during heavy summer rains sometimes cause crop damage.

Ponding and a seasonal high water table delay tillage and seeding in some areas. A system of field drains, road ditches, and channels carries the ponded water to lakes and helps to lower the water table. The drainage system improves the timeliness of tillage and seeding. It generally reduces the extent of wetland wildlife habitat, however, and affects the water regime in the lakes that receive the runoff. In some drained areas, soil salinity has increased.

Measures that conserve moisture are needed if crop production is to be successful on droughty soils. They also make it possible to lessen the frequency of summer fallow on all cropland. Some of the effective measures are a system of conservation tillage that leaves crop residue on the surface, windbreaks, annual crop barriers, and buffer strips. The crop residue traps snow and improves infiltration. The annual crop barriers and buffer strips result in a uniform distribution of snow throughout the field.

All soils that are used for cultivated crops or for pasture should be tested to determine their nutrient deficiencies. In areas used for dryland farming, the kind and amount of fertilizer to be applied should be based on the results of soil tests and on the content of moisture in the soil at the time of application.

Applying herbicide can control weeds. Care should be taken to ensure that the correct kind is applied at a rate

based on the soil conditions. The colloidal clay and humus fraction is responsible for most of the chemical activity in soils. Therefore, applying an excessive amount of herbicide can damage crops in areas where the organic matter content is moderately low or low. Application rates should be correspondingly lowered in these areas.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce crop yields in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soil or soils specified in the name of the map unit. In Ramsey County a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected annual yield per acre. Overly silty clay loam, 0 to 3 percent slopes, for example, has a productivity index of 95, which when multiplied by 40 and then divided by 100, converts to 38, which is the expected annual yield of spring wheat in bushels per acre for this map unit. (See table 6.)

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is

limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland, Windbreaks, and Environmental Plantings

Prepared by Bruce C. Wight, forester, Soil Conservation Service.

Ramsey County has approximately 6,840 acres of native woodland (*8*). Most of this woodland is adjacent to Devils Lake. The woodland on the uplands surrounding Devils Lake is primarily areas of Bottineau loam. Native trees also grow in the beach areas around the lake. The principal soil in the beach areas is Wamduska loamy sand.

The upland forest type is made up primarily of bur oak, green ash, and American elm. Other less common species include quaking aspen, basswood, common chokecherry, hackberry, hawthorn, American plum, silverberry, currant, dogwood, woods rose, juneberry, and silver buffaloberry. The dominant species in the beach areas include plains cottonwood, various species of willow, and a limited amount of American elm.

Early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using trees for fuel. The principal uses of trees, however, are for protection and esthetic purposes. The trees protect the soil, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in Ramsey County since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock. In the late 1930's, approximately 2,400 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service. Since that time, more than 3,000,000 trees have been planted on about 4,300 acres by county farmers and landowners assisted by the Soil Conservation Service and the Ramsey County Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made: (1) the purpose of the planting, (2) the suitability of the soils, (3) the adaptability of the various species of trees and shrubs, (4) the location and design of the windbreak, and (5) selection of a source of hardy and adapted trees and shrubs. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the planting is made, and the competing vegetation should be controlled for the life of the windbreak. Some replanting of the trees and shrubs may be necessary during the first 2 years after planting.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Prepared by James R. Thompson, resource conservationist, Soil Conservation Service.

Recreation facilities are very much in demand in Ramsey County since the increased water level in Devils Lake has made it one of the premiere fishing and boating lakes in North Dakota. Although the necessary facilities have not kept pace with demand, many sites are available for public use. Nearly every town in the county has a municipal park.

Five publicly administered camping or access areas and three privately owned areas are available. They provide food, fishing supplies, and a variety of services, including overnight camping, picnicking, and boat access.

The county also has more than 14,000 acres of undeveloped areas available for public use. This acreage includes 6,891 acres of federal refuges, 7,699 acres of federal waterfowl production areas, and 375 acres of state game management areas. The undeveloped areas are available for such activities as hunting, hiking, nature study, bird watching, and photography.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Prepared by Erling Podoll, biologist, Soil Conservation Service.

Fish and other wildlife are major resources in Ramsey County. In 1981, about 7.4 percent of the fishing licenses sold in North Dakota were purchased in Ramsey County and more than 2.6 percent of the hunting licenses were purchased in the county. Almost 20 percent of the county population hunts waterfowl.

Goose hunting attracts out-of-county residents as well as many out-of-state hunters. Fishing on Devils Lake attracts many people from outside the county. These two resources are a major stimulant to the local economy.

Wildlife populations are much lower than they were when the county was settled. Habitat quality and diversity are still good, but the amount of wetland and rangeland habitat has been reduced.

Important bird species in the county include game species, such as gray partridge, ducks, and geese. The habitat for pheasant and sharp-tailed grouse is limited.

Important mammal species include cottontail rabbits, white-tailed jackrabbits, white-tailed deer, tree squirrels, mink, raccoon, badger, striped skunk, red fox, and muskrat. The average annual white-tailed deer harvest is about 450 animals.

Ramsey County has about 70,000 acres of undrained soils in basins that produce vegetation associated with wetlands. It also has about 25,500 acres of meandered wetlands, not including the meandered wetlands in Devils Lake. Private landowners manage about 32,000 acres of wetland habitat and about 10,000 acres of upland habitat.

The Fish and Wildlife Service manages 7,699 acres of wetlands and upland habitat as waterfowl production areas. Landowners sold their drainage rights on 28,500 acres of wetland to the federal government under the Small Wetlands Acquisition Program. About 6,891 acres of wetland and upland habitat is managed for wildlife in the Lake Alice National Wildlife Refuge. The North Dakota Game and Fish Department manages two wildlife areas totaling 375 acres.

The county has two fishing lakes—Devils Lake and Kavanaugh Lake. The potential for developing new fishing waters or improving existing water areas is poor.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are tall wheatgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, wheatgrass, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are juneberry, common chokecherry, silver buffaloberry, and snowberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, meadowlark, sharp-tailed grouse, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, meadowlark, and lark bunting.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter,

and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limi-

tations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the

soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*14*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that have a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has a udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*13*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*14*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aberdeen Series

The Aberdeen series consists of deep, moderately well drained, slowly permeable soils on glacial lake plains. These soils formed in moderately fine textured lacustrine sediments. Slope is 0 to 1 percent.

Aberdeen soils are similar to Cresbard soils and are commonly adjacent to Colvin, Fargo, Hamerly, and Overly soils. Cresbard soils have a clay loam subsoil and substratum. Colvin, Fargo, and Overly soils do not have an alkali (sodic) subsoil or substratum. Colvin and Hamerly soils have a layer of lime accumulation within a depth of 16 inches. Fargo soils are poorly drained and have a silty clay and silty clay loam substratum. Overly

soils are higher on the landscape than the Aberdeen soils, and Colvin, Fargo, and Hamerly soils are lower.

Typical pedon of Aberdeen silty clay loam, in an area of Aberdeen-Fargo silty clay loams, 2,075 feet west and 195 feet north of the southeast corner of sec. 30, T. 156 N., R. 63 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium granular structure; hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

B/E—6 to 8 inches; very dark gray (10YR 3/1) silty clay loam (B), dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to weak thin platy; gray (10YR 6/1) dry coatings on faces of peds; hard, friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

Bt—8 to 17 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; few thin patchy clay films on faces of peds; neutral; clear wavy boundary.

Bk—17 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky and plastic; black (10YR 2/1) coatings on faces of peds; few fine threads of lime; slight effervescence; moderately alkaline; clear wavy boundary.

Bky—20 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and plastic; small masses of gypsum; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

BCky—22 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few masses of gypsum; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—32 to 40 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; common fine prominent yellowish brown (10YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; hard, friable, slightly sticky and slightly plastic; few small spots of manganese; few thin layers of very fine sandy loam; laminated; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—40 to 60 inches; olive brown (2.5Y 4/4) silty clay loam, pale yellow (2.5Y 7/4) dry; common fine prominent yellowish brown (10YR 5/6), common medium distinct light brownish gray (2.5Y 6/2), and common medium faint light olive brown (2.5Y 5/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; few thin layers of very fine sand and silty clay; few fine threads of gypsum; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 17 to 36 inches. The depth to carbonates ranges from 17 to 22 inches. The Ap horizon is silt loam or silty clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2.

Arvilla Series

The Arvilla series consists of deep, somewhat excessively drained, rapidly permeable soils on glacial beaches and outwash plains. These soils formed in moderately coarse textured material overlying coarse textured glacial outwash or beach deposits. Slope ranges from 1 to 6 percent.

Arvilla soils are commonly adjacent to Renshaw, Sioux, and Wyrene soils. Renshaw soils have a loam surface layer. Sioux soils contain more gravel in the upper part than the Arvilla soils. Wyrene soils have a layer of lime accumulation within a depth of 16 inches. Sioux soils are higher on the landscape than the Arvilla soils, and Renshaw and Wyrene soils are lower.

Typical pedon of Arvilla sandy loam, 1 to 6 percent slopes, 1,040 feet north and 1,820 feet west of the southeast corner of sec. 1, T. 156 N., R. 66 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; about 5 percent gravel; moderately alkaline; abrupt smooth boundary.

A—7 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to weak fine and medium subangular blocky; soft, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

Bw—9 to 15 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak coarse prismatic structure parting to weak fine and medium subangular blocky; soft, very friable, nonsticky and nonplastic; about 3 percent gravel; mildly alkaline; abrupt smooth boundary.

2C1—15 to 24 inches; dark brown (10YR 4/3) gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; lime coatings on underside of pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—24 to 60 inches; brown (10YR 5/3) very gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; lime coatings on underside of pebbles; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to sand and gravel range from 14 to 25 inches. The mollic epipedon ranges from 8 to 18 inches in thickness. The content of gravel in the 2C horizon ranges from 5 to 35 percent.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 1 to 25 percent.

Barnes soils are commonly adjacent to Buse, Hamerly, Langhei, and Svea soils. Buse and Langhei soils do not have a Bw horizon. Hamerly soils are somewhat poorly drained and have a layer of lime accumulation within 16 inches of the surface. Svea soils have a mollic epipedon that is more than 16 inches thick. Buse and Langhei soils are higher on the landscape than the Barnes soils, and Hamerly and Svea soils are lower.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 3 to 6 percent slopes, 2,490 feet north and 60 feet east of the southwest corner of sec. 31, T. 154 N., R. 64 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; neutral; abrupt smooth boundary.

A—6 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; mildly alkaline; abrupt irregular boundary.

Bw1—9 to 13 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few thin very dark brown (10YR 2/2) films on faces of peds; neutral; abrupt irregular boundary.

Bw2—13 to 15 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bk—15 to 26 inches; light olive brown (2.5Y 5/4) clay loam, light gray (2.5Y 7/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; lime disseminated throughout and in a few soft masses; violent effervescence; moderately alkaline; clear wavy boundary.

C1—26 to 30 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent red (2.5YR 4/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—30 to 42 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent red (2.5YR 4/8) mottles; massive; slightly hard, firm, sticky and plastic; about 3 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—42 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent red (2.5YR 4/8) mottles; massive; slightly hard, firm, sticky and plastic; about 3 percent gravel; moderately alkaline; strong effervescence.

The thickness of the solum ranges from 15 to 32 inches. The mollic epipedon ranges from 8 to 16 inches in thickness.

The Ap and A horizons have value of 2 or 3 (3 or 4 dry) and chroma of 1. They range in combined thickness from 7 to 9 inches. The Bw horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 or 3. It is clay loam or loam. The C horizon also is clay loam or loam. It has chroma of 2 to 4.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial lake plains. These soils formed in moderately fine textured and fine textured lacustrine sediments. Slope is 0 to 1 percent.

Bearden soils are commonly adjacent to Colvin, Fargo, Great Bend, Hegne, and Overly soils. Colvin soils are poorly drained and very poorly drained. Fargo and Hegne soils are poorly drained. They contain more clay than the Bearden soils. Great Bend and Overly soils are better drained than the Bearden soils. They have a Bw horizon. Colvin, Fargo, and Hegne soils are lower on the landscape than the Bearden soils, and Great Bend and Overly soils are higher.

Typical pedon of Bearden silty clay loam, 1,250 feet north and 225 feet west of the southeast corner of sec. 2, T. 156 N., R. 65 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; abrupt smooth boundary.

ABk—9 to 18 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) silty clay loam, dark gray (10YR 4/1) and gray (10YR 5/1) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine soft masses of lime; strong effervescence; mildly alkaline; clear irregular boundary.

Bk—18 to 26 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C1—26 to 35 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent gray (5Y 5/1) and dark yellowish brown (10YR 4/4) mottles; weak coarse subangular blocky structure parting to moderate fine and medium subangular blocky; slightly hard, friable, sticky and plastic; violent effervescence; moderately alkaline; clear wavy boundary.

C2—35 to 39 inches; olive (5Y 5/3) silty clay loam, pale yellow (5Y 7/3) dry; common medium distinct gray (5Y 5/1) and common fine prominent dark yellowish brown (10YR 4/4) mottles; massive; hard, friable, sticky and plastic; strong effervescence; moderately alkaline; clear wavy boundary.

C3—39 to 50 inches; olive (5Y 5/3), gray (5Y 5/1), and yellowish brown (10YR 5/6) laminated silty clay and silty clay loam, pale yellow (5Y 7/3), light gray (5Y 7/2), and yellow (10YR 7/6) dry; massive; slightly hard, friable, sticky and plastic; strong effervescence; moderately alkaline; clear wavy boundary.

C4—50 to 60 inches; gray (5Y 5/1) and olive (5Y 5/3) laminated silty clay loam and silty clay, light gray (5Y 7/1) and pale yellow (5Y 7/3) dry; common medium prominent dark yellowish brown (10YR 4/4) mottles; massive; slightly hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 9 to 20 inches in thickness. Some pedons do not have an ABk horizon. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4. In some pedons the C horizon is loam below a depth of 40 inches.

Bottineau Series

The Bottineau series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 1 to 6 percent.

Bottineau soils are commonly adjacent to Barnes, Buse, Parnell, and Tonka soils. Barnes and Buse soils do not have a subsoil layer of clay accumulation. Parnell soils are very poorly drained, and Tonka soils are poorly drained. Buse soils are higher on the landscape than the Bottineau soils, and Parnell and Tonka soils are lower. Barnes soils are in positions on the landscape similar to those of the Bottineau soils.

Typical pedon of Bottineau loam, 3 to 6 percent slopes, 2,755 feet west and 590 feet south of the northeast corner of sec. 19, T. 153 N., R. 64 W.

A1—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common uncoated sand grains on faces of peds; neutral; clear smooth boundary.

A2—4 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common uncoated sand grains on faces of peds; neutral; clear wavy boundary.

Bt1—9 to 12 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong medium blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; common uncoated sand grains on faces of peds; neutral; clear irregular boundary.

Bt2—12 to 20 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to strong medium blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; common uncoated sand grains on faces of peds; neutral; clear wavy boundary.

Bk1—20 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; few medium soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

Bk2—24 to 30 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; common soft masses and threads of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

C1—30 to 44 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; massive; slightly hard, firm, sticky and plastic; about 3 percent gravel; common soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—44 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, firm, sticky and plastic; about 3 percent gravel; common soft masses of lime; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 50 inches. The mollic epipedon ranges from 11 to 16 inches in thickness. The Bt1 horizon has hue of 10YR, value of 2 to 5 (4 to 6 dry), and chroma of 1 to 3. The Bk horizon has hue of 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The C horizon is loam or clay loam.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 3 to 15 percent.

Buse soils are commonly adjacent to Barnes, Langhei, and Svea soils. Barnes soils have a Bw horizon. Langhei soils do not have a mollic epipedon. Svea soils have a mollic epipedon that is more than 16 inches thick. Barnes and Svea soils are lower on the landscape than the Buse soils, and Langhei soils are higher.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 6 to 9 percent slopes, 35 feet south and 2,185 feet west of the northeast corner of sec. 29, T. 154 N., R. 65 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—7 to 16 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; about 3 percent gravel; lime disseminated throughout; violent effervescence; mildly alkaline; diffuse wavy boundary.

Bk2—16 to 35 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine prominent red (2.5YR 4/8) mottles; weak medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; about 3 percent gravel; common medium soft masses of lime; violent effervescence; moderately alkaline; diffuse wavy boundary.

C—35 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, sticky and plastic; about 3 percent gravel; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 9 inches thick. The depth to carbonates ranges from 0 to 9 inches.

The Ap horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1. The Bk horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4. The C horizon has hue of 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. It is clay loam or loam.

Colvin Series

The Colvin series consists of deep, poorly drained and very poorly drained, moderately slowly permeable soils on glacial lake plains and in glacial outwash channels. These soils formed in medium textured and moderately fine textured lacustrine sediments. Slope is 0 to 1 percent.

Colvin soils are similar to Ojata soils and are commonly adjacent to Aberdeen, Bearden, Fargo, Hegne, and Overly soils. Ojata soils are strongly saline and contain more salts in the surface layer than the Colvin soils. Aberdeen soils have an alkali (sodic) layer and are moderately well drained. Bearden soils are somewhat poorly drained and have light olive brown and olive colors in the substratum. Fargo and Hegne soils contain more clay than the Colvin soils. Overly soils are moderately well drained. Aberdeen, Bearden, and Overly soils are higher on the landscape than the Colvin soils. Fargo, Hegne, and Ojata soils are in positions on the landscape similar to those of the Colvin soils.

Typical pedon of Colvin silty clay loam, saline, 515 feet west and 240 feet south of the northeast corner of sec. 35, T. 154 N., R. 64 W.

Az—0 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine salt crystals; strong effervescence; moderately alkaline; clear smooth boundary.

Bk—11 to 24 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, sticky and plastic; tongues of black (10YR 2/1) A horizon extending throughout; lime disseminated throughout; strong effervescence; moderately alkaline; clear wavy boundary.

Bky—24 to 38 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; common fine prominent light olive brown (2.5Y 5/6) and common fine distinct light olive brown (2.5Y 5/4) mottles; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm, sticky and plastic; thin tongues of black (10YR 2/1) A horizon extending to 30 inches; small nests of gypsum; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—38 to 60 inches; grayish brown (2.5Y 5/2) laminated silty clay loam and silt loam, light gray (2.5Y 7/2) dry; many medium and large prominent yellowish brown (10YR 5/6), many large distinct light olive brown (2.5Y 5/4), and common medium prominent brownish yellow (10YR 6/6) mottles; massive; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 8 to 12 inches in thickness. Some pedons do not have gypsum, and some are nonsaline. The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 or 2. The Cg horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 or 3.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 1 to 6 percent.

Cresbard soils are similar to Aberdeen soils and are commonly adjacent to Barnes, Hamerly, and Svea soils. Aberdeen soils have a silty clay and silty clay loam subsoil and a silty clay loam substratum. Barnes, Hamerly, and Svea soils do not have an alkali (sodic) layer in the subsoil or substratum. Barnes and Svea soils are higher on the landscape than the Cresbard soils, and Hamerly soils are lower.

Typical pedon of Cresbard loam, in an area of Svea-Cresbard loams, 1 to 3 percent slopes, 670 feet east and 80 feet north of the southwest corner of sec. 34, T. 157 N., R. 64 W.

A—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, very friable, nonsticky and slightly plastic; neutral; clear smooth boundary.

E—6 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium platy structure; slightly hard, very friable, nonsticky and slightly plastic; slightly acid; clear wavy boundary.

B/E—7 to 9 inches; very dark grayish brown (10YR 3/2) clay loam (B), dark grayish brown (10YR 4/2) dry; moderate medium and coarse prismatic structure parting to strong medium angular blocky; gray (10YR 5/1 dry) coatings (E) on faces of peds; hard, firm, sticky and plastic; neutral; clear irregular boundary.

Bt1—9 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, sticky and plastic; many moderately thick clay films on faces of peds; moderately alkaline; gradual irregular boundary.

Bt2—14 to 18 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, sticky and plastic; many moderately thick clay films on faces of peds; moderately alkaline; gradual irregular boundary.

Bk—18 to 24 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common fine accumulations of lime; strong effervescence; strongly alkaline; gradual wavy boundary.

BCky—24 to 36 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; massive; hard, friable, sticky and plastic; common crystals of gypsum; common fine accumulations of lime; violent effervescence; strongly alkaline; clear wavy boundary.

C—36 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; massive; very hard, friable, sticky and plastic; many fine accumulations of lime; strong effervescence; strongly alkaline.

The thickness of the solum ranges from 15 to 40 inches. Some pedons do not have an E horizon. The Bt horizon has hue of 2.5Y or 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. It is clay loam or silty clay. The C horizon is loam or clay loam.

Divide Series

The Divide series consists of deep, somewhat poorly drained soils on glacial outwash plains. These soils formed in medium textured sediments over coarse textured, medium textured, and moderately fine textured sediments. Permeability is moderate in the upper part of the profile, rapid in the next part, and moderately slow in the lower part. Slope ranges from 1 to 3 percent.

Divide soils are similar to Hamerly soils and are commonly adjacent to Arvilla, Hamerly, Renshaw, Svea, and Wyrene soils. Hamerly soils have a clay loam or loam substratum. Arvilla and Renshaw soils are better drained than the Divide soils. They have a Bw horizon. Svea soils are moderately well drained. Wyrene soils contain more sand than the Divide soils. Arvilla and Renshaw soils are higher on the landscape than the Divide soils, and Wyrene soils are lower.

Typical pedon of Divide loam, loamy substratum, 1 to 3 percent slopes, 1,485 feet south and 270 feet west of the northeast corner of sec. 24, T. 158 N., R. 63 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; mildly alkaline; clear wavy boundary.

Bk1—11 to 20 inches; dark gray (10YR 4/1) loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; soft, friable, slightly sticky and slightly plastic; about 5 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—20 to 28 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; about 5 percent

gravel; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

2C—28 to 46 inches; yellowish brown (10YR 5/4) very gravelly sand, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/4) dry; single grain; loose, nonsticky and nonplastic; about 50 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.

3Cg—46 to 60 inches; olive (5Y 5/3) clay loam, pale yellow (5Y 7/3) dry; few large prominent yellowish red (5YR 5/6) mottles; massive; very hard, firm, slightly sticky and plastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. The depth to the 3C horizon ranges from 45 to 55 inches. The 2C horizon is gravelly loamy sand or very gravelly sand. The content of gravel in this horizon is 25 to 60 percent. Some of the gravel is soft shale. The 3C horizon is loam or clay loam.

Embden Series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on glacial lake plains. These soils formed in medium textured and moderately coarse textured lacustrine sediments over coarse textured lacustrine sediments. Slope ranges from 0 to 3 percent.

Embden soils are similar to Emrick soils and are commonly adjacent to Glyndon and Hamerly soils. Emrick soils have a loam subsoil and contain gravel in the substratum. Glyndon and Hamerly soils have a layer of lime accumulation within a depth of 16 inches. They are lower on the landscape than the Embden soils.

Typical pedon of Embden loam, 0 to 3 percent slopes, 375 feet east and 2,465 feet north of the southwest corner of sec. 18, T. 156 N., R. 66 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

A—8 to 19 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

Bw1—19 to 26 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bw2—26 to 35 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; few fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; neutral; gradual wavy boundary.

BCk—35 to 48 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent grayish brown (10YR 5/2) mottles; massive; soft, very friable, slightly sticky and slightly plastic; lime disseminated throughout; strong effervescence; mildly alkaline; gradual wavy boundary.

C—48 to 60 inches; olive brown (2.5Y 4/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; common medium prominent grayish brown (10YR 5/2) and few fine prominent dark reddish brown (5YR 3/3) mottles; massive; soft, very friable, slightly sticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness. The thickness of the solum and the depth to carbonates range from 20 to 52 inches.

Emrick Series

The Emrick series consists of deep, moderately well drained, moderately permeable soils on glacial till plains. These soils formed in medium textured glacial till over coarse textured glacial till. Slope ranges from 3 to 9 percent.

Emrick soils are similar to Embden soils and are commonly adjacent to Esmond and Sioux soils. Embden soils have a fine sandy loam subsoil and do not have gravel in the substratum. Esmond soils have a mollic epipedon that is less than 14 inches thick. Sioux soils contain more sand and gravel than the Emrick soils. Sioux and Esmond soils are higher on the landscape than the Emrick soils.

Typical pedon of Emrick loam, in an area of Esmond-Emrick loams, 3 to 9 percent slopes, 1,090 feet east and 630 feet north of the southwest corner of sec. 8, T. 155 N., R. 64 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many medium and fine roots; mildly alkaline; abrupt smooth boundary.

A—7 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many medium and fine roots; mildly alkaline; clear wavy boundary.

Bw—12 to 28 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; about 5 percent

coarse fragments; mildly alkaline; clear wavy boundary.

Bk—28 to 50 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; about 5 percent coarse fragments; common soft masses of lime; violent effervescence; moderately alkaline; abrupt smooth boundary.

2C—50 to 60 inches; dark grayish brown (2.5Y 4/2) loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness. The depth to the 2C horizon ranges from 42 to 60 inches. Some pedons do not have a 2C horizon.

Esmond Series

The Esmond series consists of deep, well drained, moderately permeable soils on glacial till plains. These soils formed in medium textured and moderately coarse textured glacial till over coarse textured glacial till. Slope ranges from 3 to 9 percent.

Esmond soils are commonly adjacent to Emrick and Sioux soils. Emrick soils have a mollic epipedon that is more than 16 inches thick. Sioux soils contain more sand and gravel than the Esmond soils. Emrick soils are lower on the landscape than the Esmond soils, and Sioux soils generally are higher.

Typical pedon of Esmond loam, in an area of Esmond-Emrick loams, 3 to 9 percent slopes, 1,110 feet east and 475 feet north of the southwest corner of sec. 8, T. 155 N., R. 64 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bw—6 to 8 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

Bk—8 to 19 inches; pale brown (10YR 6/3) loam, very pale brown (10YR 7/3) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; about 2 percent coarse fragments; lime disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Cl—19 to 38 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C2—38 to 56 inches; light olive brown (2.5Y 5/4) sandy loam, pale yellow (2.5Y 7/4) dry; few fine prominent strong brown (7.5YR 4/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—56 to 60 inches; olive brown (2.5Y 4/4) loamy sand, light yellowish brown (2.5Y 6/4) dry; single grain; soft, loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 10 inches in thickness.

Fargo Series

The Fargo series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. These soils formed in moderately fine textured and fine textured lacustrine sediments. Slope is 0 to 1 percent.

Fargo soils are similar to Grano soils and are commonly adjacent to Aberdeen, Bearden, Grano, and Hegne soils. Aberdeen soils have an alkali (sodic) layer in the subsoil or substratum. Bearden and Hegne soils have a layer of lime accumulation within a depth of 16 inches. Grano soils do not have a Bw horizon. Aberdeen, Bearden, and Hegne soils are higher on the landscape than the Fargo soils, and Grano soils are lower.

Typical pedon of Fargo silty clay loam, in an area of Aberdeen-Fargo silty clay loams, 1,580 feet east and 1,185 feet south of the northwest corner of sec. 31, T. 156 N., R. 63 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable, sticky and plastic; neutral; abrupt smooth boundary.

Bw1—7 to 12 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) and dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong very fine blocky; hard, firm, very sticky and very plastic; black (10YR 2/1) tongues extending throughout; mildly alkaline; clear irregular boundary.

Bw2—12 to 19 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; common large distinct very dark gray (10YR 3/1) mottles; moderate medium prismatic structure parting to strong very fine blocky; hard, firm, very sticky and very plastic; black (10YR 2/1) tongues extending throughout; slight effervescence in the lower part; mildly alkaline; clear irregular boundary.

Bk—19 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few

fine distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; slightly hard, firm, very sticky and very plastic; lime disseminated throughout and in soft masses; strong effervescence; moderately alkaline; clear wavy boundary.

Cg1—28 to 40 inches; olive (5Y 4/3) laminated silty clay and silty clay loam, pale olive (5Y 6/3) dry; common medium distinct gray (5Y 6/1) mottles; massive; slightly hard, firm, very sticky and very plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg2—40 to 60 inches; olive (5Y 5/3) laminated silty clay and silty clay loam, pale yellow (5Y 7/3) dry; common medium distinct gray (5Y 6/1) and common medium faint pale olive (5Y 6/3) mottles; massive; hard, firm, very sticky and very plastic; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 32 inches. The mollic epipedon ranges from 16 to 24 inches in thickness. The A horizon is silty clay loam or silty clay. The tongues of A material that extend through the Bw horizon are 1/2 inch to 2 inches wide. The Bw horizon is silty clay or clay.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glacial lake plains. These soils formed in moderately fine textured and medium textured lacustrine sediments. Slope ranges from 0 to 3 percent.

Glyndon soils are commonly adjacent to Bearden, Embden, Hamerly, and Overly soils. Bearden soils contain more clay than the Glyndon soils. Embden soils are moderately well drained and have a Bw horizon. Hamerly soils contain more clay and sand in the substratum than the Glyndon soils. Overly soils are moderately well drained, have a Bw horizon, and contain more clay than the Glyndon soils. Bearden and Hamerly soils are in positions on the landscape similar to those of the Glyndon soils. Embden and Overly soils are higher on the landscape than the Glyndon soils.

Typical pedon of Glyndon silt loam, 0 to 3 percent slopes, 1,400 feet west and 110 feet south of the northeast corner of sec. 4, T. 157 N., R. 64 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—8 to 13 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—13 to 30 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 54 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common medium faint light yellowish brown (2.5Y 6/4) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—54 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; many medium distinct light brownish gray (2.5Y 6/2) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 10 inches in thickness. The C horizon typically is silty clay loam or silt loam, but in some pedons it is very fine sand or loamy fine sand below a depth of 40 inches.

Grano Series

The Grano series consists of deep, very poorly drained, slowly permeable soils on glacial lake plains and till plains. These soils formed in moderately fine textured and fine textured sediments. Slope is 0 to 1 percent.

Grano soils are similar to Fargo soils and are commonly adjacent to Fargo, Hegne, and Vallers soils. Fargo soils have a Bw horizon. Hegne and Vallers soils have a layer of lime accumulation within a depth of 16 inches. Also, Vallers soils contain less clay than the Grano soils. Fargo, Hegne, and Vallers soils are higher on the landscape than the Grano soils.

Typical pedon of Grano silty clay, 690 feet north and 395 feet west of the southeast corner of sec. 35, T. 154 N., R. 64 W.

Ap—0 to 8 inches; black (5Y 2/1) silty clay, very dark gray (5Y 3/1) dry; strong fine angular blocky structure; hard, firm, sticky and plastic; mildly alkaline; abrupt smooth boundary.

Ag—8 to 14 inches; black (5Y 2/1) silty clay, very dark gray (5Y 3/1) dry; strong fine blocky structure; hard, firm, very sticky and very plastic; slight effervescence; mildly alkaline; clear irregular boundary.

Cg1—14 to 20 inches; grayish brown (2.5Y 5/2) silty clay, light gray (2.5Y 7/2) dry; common medium distinct gray (N 5/0) mottles; moderate medium and fine blocky structure; hard, very firm, very sticky and very plastic; few black (5Y 2/1) tongues of A horizon

material extending throughout; strong effervescence; moderately alkaline; diffuse wavy boundary.

Cg2—20 to 29 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/2) dry; few medium prominent dark brown (10YR 4/3) and common medium distinct gray (N 5/0) mottles; strong medium and fine blocky structure; hard, very firm, very sticky and very plastic; strong effervescence; moderately alkaline; diffuse wavy boundary.

Cg3—29 to 39 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many medium prominent light olive brown (2.5Y 5/6) mottles; massive; very hard, very firm, very sticky and very plastic; strong effervescence; mildly alkaline; diffuse wavy boundary.

Cg4—39 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; many medium prominent light olive brown (2.5Y 5/6) and gray (N 5/0) mottles; massive; very hard, very firm, very sticky and very plastic; strong effervescence; mildly alkaline.

The mollic epipedon ranges from 8 to 18 inches in thickness. The Cg horizon has hue of 5Y or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. It is silty clay, silty clay loam, or clay loam below a depth of 40 inches. Some pedons have gypsum crystals below a depth of 30 inches.

Great Bend Series

The Great Bend series consists of deep, well drained, moderately permeable soils on glacial lake plains. These soils formed in medium textured and moderately fine textured glacial lacustrine sediments. Slope ranges from 3 to 6 percent.

Great Bend soils are commonly adjacent to Bearden, Colvin, Overly, and Zell soils. Bearden and Colvin soils have a layer of lime accumulation within a depth of 16 inches. Overly soils have a mollic epipedon that is more than 16 inches thick. Zell soils do not have a cambic horizon. Bearden, Colvin, and Overly soils are lower on the landscape than the Great Bend soils, and Zell soils are higher.

Typical pedon of Great Bend silty clay loam, in an area of Great Bend-Overly silty clay loams, 3 to 6 percent slopes, 890 feet north and 460 feet east of the southwest corner of sec. 8, T. 154 N., R. 66 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A—6 to 10 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure parting to weak fine and medium granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; neutral; clear wavy boundary.

Bw—10 to 16 inches; very dark grayish brown (2.5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; mildly alkaline; abrupt wavy boundary.

Bk—16 to 37 inches; light olive brown (2.5Y 5/4) silt loam, light gray (2.5Y 7/2) dry; moderate very coarse and coarse prismatic structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; lime disseminated throughout; violent effervescence; moderately alkaline; abrupt smooth boundary.

BCky—37 to 46 inches; light olive brown (2.5Y 5/4) laminated silt loam and silty clay loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; lime disseminated throughout; common medium nests of gypsum; violent effervescence; mildly alkaline; abrupt smooth boundary.

C—46 to 60 inches; light olive brown (2.5Y 5/4) laminated silt loam and silty clay loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 8 to 16 inches in thickness. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. The Bw and C horizons are silt loam or silty clay loam.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 0 to 6 percent.

Hamerly soils are similar to Divide soils and are commonly adjacent to Aberdeen, Cresbard, Svea, and Vallers soils. Divide soils have a very gravelly sand 2C horizon. Aberdeen and Cresbard soils have an alkali (sodic) layer in the subsoil or substratum. Svea soils have a mollic epipedon that is more than 16 inches thick. Vallers soils are poorly drained. Aberdeen, Cresbard, and Svea soils are higher on the landscape than the Hamerly soils, and Vallers soils are lower.

Typical pedon of Hamerly loam, in an area of Hamerly-Cresbard loams, 1 to 3 percent slopes, 630 feet south and 535 feet west of the northeast corner of sec. 16, T. 155 N., R. 63 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly

plastic; about 3 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

ABk—6 to 16 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; soft, friable, slightly sticky and slightly plastic; about 5 percent gravel; lime disseminated throughout and in soft masses; violent effervescence; moderately alkaline; clear wavy boundary.

Bk—16 to 28 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—28 to 44 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine and medium prominent red (2.5YR 4/6) mottles; weak coarse prismatic structure parting to weak fine and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

C2—44 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common fine and medium prominent red (2.5YR 4/6) mottles; massive; hard, firm, slightly sticky and plastic; about 3 percent gravel; few large nests of gypsum; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 15 inches in thickness. Some pedons are saline. The Bk and C horizons are loam or clay loam. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 1 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4.

Hegne Series

The Hegne series consists of deep, poorly drained, very slowly permeable soils on glacial lake plains. These soils formed in fine textured lacustrine sediments. Slope is 0 to 1 percent.

Hegne soils are commonly adjacent to Bearden, Fargo, Grano, and Hamerly soils. Bearden soils contain less clay and more silt than the Hegne soils. Fargo and Grano soils do not have a layer of lime accumulation within a depth of 16 inches. Also, Fargo soils have a Bw horizon. Hamerly soils contain less clay and more sand than the Hegne soils. Bearden and Hamerly soils are higher on the landscape than the Hegne soils, and Fargo and Grano soils are lower.

Typical pedon of Hegne silty clay, 880 feet west and 1,700 feet south of the northeast corner of sec. 19, T. 157 N., R. 64 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate coarse and medium subangular blocky structure; very hard, firm, sticky and plastic; common fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

Bkg—8 to 30 inches; dark gray (5Y 4/1) clay, gray (5Y 5/1) dry; moderate medium and fine blocky structure; very hard, firm, sticky and plastic; few fine roots; few black (10YR 2/1) tongues and streaks of A horizon material extending to a depth of about 16 inches; lime disseminated throughout; violent effervescence; mildly alkaline; gradual wavy boundary.

BCk—30 to 45 inches; grayish brown (2.5Y 5/2) silty clay, light gray (2.5Y 7/2) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; very hard, very firm, very sticky and very plastic; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—45 to 60 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; many medium distinct gray (N 5/0), few medium distinct very dark brown (10YR 2/2), and light olive brown (2.5Y 5/4) mottles; massive; very hard, very firm, very sticky and very plastic; common nests of gypsum; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 8 to 15 inches in thickness. Some pedons are saline. The Bk, BCk, and Cg horizons are silty clay or clay. The Cg horizon has hue of 2.5Y or 5Y.

Lallie Series

The Lallie series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. These soils formed in fine textured and moderately fine textured lacustrine sediments. Slope is 0 to 1 percent.

Lallie soils are commonly adjacent to Mauvais, Minnewaukan, and Wamduska soils. Mauvais soils are somewhat poorly drained. Minnewaukan soils contain more sand than the Lallie soils. Wamduska soils are excessively drained and contain more sand and gravel than the Lallie soils. Mauvais and Wamduska soils are higher on the landscape than the Lallie soils. Minnewaukan soils are in positions on the landscape similar to those of the Lallie soils.

Typical pedon of Lallie clay loam, 170 feet east and 360 feet south of the northwest corner of sec. 33, T. 154 N., R. 64 W.

Ap—0 to 5 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; moderate fine and medium granular structure; slightly hard, firm, sticky and plastic; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cg1—5 to 15 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine

distinct gray (5Y 6/1) and common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine blocky; hard, very firm, very sticky and very plastic; few small nests of gypsum; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—15 to 26 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) laminated silty clay and clay, grayish brown (2.5Y 5/2) and light gray (2.5Y 7/2) dry; massive; hard, very firm, very sticky and very plastic; few small nests of gypsum; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg3—26 to 35 inches; grayish brown (2.5Y 5/2) laminated silty clay and clay, light gray (2.5Y 7/2) dry; common fine prominent gray (5Y 6/1), few fine prominent yellowish brown (10YR 5/6), and many large distinct olive yellow (2.5Y 6/6) mottles; massive; very hard, very firm, very sticky and very plastic; few small nests of gypsum; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg4—35 to 42 inches; grayish brown (2.5Y 5/2) laminated silty clay and clay, light gray (2.5Y 7/2) dry; common medium faint dark grayish brown (2.5Y 4/2), few fine prominent strong brown (7.5YR 5/6), common medium distinct gray (5Y 6/1), and common fine distinct olive yellow (2.5Y 6/6) mottles; massive; very hard, very firm, very sticky and very plastic; common nests of gypsum; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cg5—42 to 60 inches; olive gray (5Y 4/2) laminated silty clay and clay, light olive gray (5Y 6/2) dry; massive; very hard, very firm, very sticky and very plastic; common nests of gypsum along lamina planes; common spots of manganese; slight effervescence; moderately alkaline.

Some pedons are saline. The Ap horizon is 3 to 5 inches thick. The Cg horizon has value of 3 to 6 (5 to 8 dry). It generally has chroma of 1 or 2, but in some pedons it has chroma of 3 or 4 below a depth of 24 inches. The C horizon is silty clay, silty clay loam, or clay.

Langhei Series

The Langhei series consists of deep, well drained, moderately permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 9 to 40 percent.

Langhei soils are commonly adjacent to Barnes and Buse soils. Barnes and Buse soils are lower on the landscape than the Langhei soils. Also, they have a darker and thicker surface layer. Barnes soils have a Bw horizon.

Typical pedon of Langhei loam, in an area of Langhei-Barnes loams, 9 to 40 percent slopes, 750 feet north and 1,250 feet west of the southeast corner of sec. 4, T. 151 N., R. 62 W.

A—0 to 4 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; slight effervescence; neutral; abrupt smooth boundary.

Bk1—4 to 15 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; common fine soft masses of lime; violent effervescence; moderately alkaline; abrupt smooth boundary.

BCk—15 to 23 inches; dark grayish brown (2.5Y 4/2) loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; few fine soft masses of lime; strong effervescence; mildly alkaline; abrupt smooth boundary.

C—23 to 60 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; few fine prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; mildly alkaline.

The A horizon is 2 to 4 inches thick. It has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. The C horizon is loam or clay loam.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on glaciolacustrine plains. These soils formed in coarse textured and moderately coarse textured wind- or water-sorted glacial sediments. Slope ranges from 3 to 9 percent.

Maddock soils are commonly adjacent to Buse, Sioux, and Zell soils. Buse soils contain more clay and silt than the Maddock soils. Sioux soils contain more gravel than the Maddock soils. Zell soils contain more silt and less sand than the Maddock soils. Buse, Sioux, and Zell soils are in positions on the landscape similar to those of the Maddock soils.

Typical pedon of Maddock fine sandy loam, in an area of Zell-Maddock complex, 3 to 9 percent slopes, 1,065 feet west and 350 feet north of the southeast corner of sec. 13, T. 154 N., R. 63 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; weak medium granular structure; loose, friable, slightly sticky and slightly plastic; strong effervescence; neutral; abrupt smooth boundary.

AC—7 to 12 inches; dark grayish brown (10YR 4/2) loamy fine sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; loose, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline; clear wavy boundary.

C1—12 to 52 inches; dark brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—52 to 60 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 12 inches in thickness. The depth to carbonates ranges from 0 to 12 inches. Some pedons do not have an AC horizon. Some have a B horizon. The C horizon is silt loam below a depth of 40 inches in some pedons.

Mauvais Series

The Mauvais series consists of deep, somewhat poorly drained, moderately slowly permeable soils on lakeshores. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 0 to 6 percent.

Mauvais soils are commonly adjacent to Lallie, Minnewaukan, and Wamduska soils. Lallie soils are poorly drained and contain more clay than the Mauvais soils. Minnewaukan soils are poorly drained and contain more sand than the Mauvais soils. Wamduska soils also contain more sand. They are excessively drained. Wamduska soils are higher on the landscape than the Mauvais soils, and Lallie and Minnewaukan soils are lower.

Typical pedon of Mauvais loam, 0 to 6 percent slopes, 2,140 feet south and 2,305 feet east of the northwest corner of sec. 18, T. 153 N., R. 63 W.

A—0 to 2 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; 2 percent gravel; strong effervescence; mildly alkaline; clear smooth boundary.

C1—2 to 50 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine prominent dark reddish brown (2.5YR 3/4) and many medium and large prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; common light brownish gray (2.5Y 6/2) coatings along vertical partings; about 2 percent gravel; few fine rounded manganese concretions; few fine nests of gypsum; strong effervescence; moderately alkaline; clear wavy boundary.

C2—50 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark reddish brown (2.5YR 3/4) and common fine distinct olive brown (2.5Y 4/4) mottles; massive; hard, friable, sticky and plastic; about 2 percent gravel; few fine rounded manganese concretions; few fine concentrations of gypsum; strong effervescence; mildly alkaline.

The 10- to 40-inch control section ranges from 18 to 35 percent clay. The content of gravel in this section typically is 1 to 10 percent. The depth to carbonates ranges from 0 to 6 inches. Soluble salts are in some pedons.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (4 or 5 dry), and chroma of 1 or 2 moist or dry. The C horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 4 or 5 (6 or 7 dry) and chroma of 0 to 4. It typically is loam but is clay loam, silt loam, or silty clay loam in some pedons. It is mildly alkaline or moderately alkaline. Some pedons have thin strata of sandy or clayey sediments.

Minnewaukan Series

The Minnewaukan series consists of deep, poorly drained, rapidly permeable soils on glacial lake plains. These soils formed in coarse textured lacustrine sediments. Slope ranges from 1 to 3 percent.

Minnewaukan soils are commonly adjacent to Lallie, Mauvais, and Wamduska soils. Lallie and Mauvais soils contain more clay than the Minnewaukan soils. Mauvais soils are somewhat poorly drained. Wamduska soils are excessively drained and contain more gravel than the Minnewaukan soils. Wamduska and Mauvais soils are higher on the landscape than the Minnewaukan soils. Lallie soils are in positions on the landscape similar to those of the Minnewaukan soils.

Typical pedon of Minnewaukan loamy fine sand, 1 to 3 percent slopes, 1,510 feet east and 20 feet south of the northwest corner of sec. 33, T. 153 N., R. 64 W.

A—0 to 4 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; about 5 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—4 to 11 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; few medium prominent dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; few very fine roots; about 10 percent gravel; slight effervescence; moderately alkaline; clear wavy boundary.

Cg1—11 to 18 inches; grayish brown (2.5Y 5/2) sand, light brownish gray (2.5Y 6/2) dry; common medium prominent dark brown (7.5YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; slight effervescence; moderately alkaline; clear wavy boundary.

Cg2—18 to 24 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; common medium prominent dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; slight effervescence; moderately alkaline; clear wavy boundary.

Cg3—24 to 40 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; common medium distinct olive brown (2.5Y 4/4) mottles; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cg4—40 to 48 inches; dark grayish brown (2.5Y 4/2) fine sand, light gray (2.5Y 7/2) dry; common large distinct light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline; clear wavy boundary.

Cg5—48 to 60 inches; grayish brown (2.5Y 5/2) sand, light brownish gray (2.5Y 6/2) dry; few medium faint dark grayish brown (2.5Y 4/2) and many medium distinct olive brown (2.5Y 4/4) mottles; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; slight effervescence; moderately alkaline.

The A horizon is 3 to 6 inches thick. The Cg1, Cg2, and Cg3 horizons are loamy fine sand, fine sand, loamy sand, or sand. Some pedons are clay loam, loam, or silt loam below a depth of 40 inches.

Ojata Series

The Ojata series consists of deep, poorly drained, slowly permeable soils on glacial till plains and lake plains. These soils formed in medium textured and moderately fine textured glacial sediments. Slope is 0 to 1 percent.

These soils have more sand and less silt than is definitive for the Ojata series. This difference, however, does not alter the usefulness or behavior of the soils.

Ojata soils are similar to Colvin soils and are commonly adjacent to Colvin, Hamerly, Southam, and Vallers soils. Colvin, Hamerly, and Vallers soils contain less salt than the Ojata soils. Southam soils are very poorly drained and are ponded during the growing season. Southam soils are lower on the landscape than the Ojata soils, and Hamerly soils are higher. Colvin and Vallers soils are in positions on the landscape similar to those of the Ojata soils.

Typical pedon of Ojata clay loam, 150 feet east and 120 feet south of the northwest corner of sec. 2, T. 154 N., R. 64 W.

Az—0 to 4 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; few medium faint dark gray (5Y 4/1) mottles; moderate medium and fine blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common fine salt crystals; slight effervescence; moderately alkaline; abrupt wavy boundary.

ABkz—4 to 9 inches; dark gray (5Y 4/1) clay loam, gray (5Y 5/1) dry; few fine faint gray (5Y 6/1) mottles; moderate medium and fine blocky structure; hard, firm, slightly sticky and slightly plastic; common fine salt crystals; lime disseminated throughout; strong effervescence; strongly alkaline; abrupt wavy boundary.

Bkz—9 to 30 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine distinct gray (N 5/0) and very dark gray (N 3/0) mottles; moderate medium and fine blocky structure; very hard, firm, slightly sticky and slightly plastic; common fine salt crystals; lime disseminated throughout; violent effervescence; strongly alkaline; diffuse wavy boundary.

Cg—30 to 60 inches; olive gray (5Y 4/2) silty clay loam, light gray (5Y 7/2) dry; few fine distinct olive (5Y 4/4) and common medium prominent gray (N 5/0) mottles; massive; very hard, very firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The Az horizon has a 1/16- to 1/2-inch coating or crust of salt. The Cg horizon is silty clay loam, loam, or clay loam.

Overly Series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake plains. These soils formed in fine textured and moderately fine textured lacustrine sediments. Slope ranges from 0 to 6 percent.

Overly soils are commonly adjacent to Aberdeen, Bearden, Colvin, and Great Bend soils. Aberdeen soils have an alkali (sodic) layer in the subsoil or substratum. Bearden and Colvin soils have a layer of lime accumulation within a depth of 16 inches. Bearden soils are somewhat poorly drained, and Colvin soils are poorly drained and very poorly drained. Great Bend soils have a dark surface soil that is less than 16 inches thick. Aberdeen, Bearden, and Colvin soils are lower on the landscape than the Overly soils, and Great Bend soils are higher.

Typical pedon of Overly silty clay loam, 0 to 3 percent slopes, 1,710 feet east and 900 feet south of the northwest corner of sec. 11, T. 156 N., R. 65 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

A—6 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine blocky structure; hard, friable, sticky and slightly plastic; neutral; clear wavy boundary.

Bw1—9 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate medium

blocky; very hard, firm, sticky and slightly plastic; neutral; clear irregular boundary.

Bw2—16 to 19 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) silty clay loam, dark grayish brown (10YR 4/2) and brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium blocky; very hard, firm, sticky and slightly plastic; moderately alkaline; gradual wavy boundary.

Bk1—19 to 24 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; weak medium prismatic structure parting to moderate fine blocky; very hard, firm, sticky and slightly plastic; irregularly shaped filaments and threads of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk2—24 to 33 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine faint light gray (2.5Y 7/2) mottles; weak medium subangular blocky structure; very hard, firm, sticky and slightly plastic; lime disseminated throughout; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—33 to 50 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; very hard, firm, sticky and slightly plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—50 to 60 inches; light olive brown (2.5Y 5/4) silty clay, light yellowish brown (2.5Y 6/4) dry; few fine distinct light olive brown (2.5Y 5/6) and grayish brown (2.5Y 5/2) mottles; massive; very hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 16 to 30 inches in thickness. The solum ranges from 18 to 37 inches in thickness. The C2 horizon is silty clay or silty clay loam.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on glacial till plains and lake plains. These soils formed in moderately fine textured and fine textured local alluvium derived from glacial till. Slope is 0 to 1 percent.

Parnell soils are commonly adjacent to Tonka and Vallers soils. Tonka soils have a dark gray subsurface layer that is more than 4 inches thick. Vallers soils are poorly drained and have a layer of lime accumulation within a depth of 16 inches. Tonka and Vallers soils are higher on the landscape than the Parnell soils.

Typical pedon of Parnell silty clay loam, in an area of Vallers-Parnell-Tonka complex, 0 to 3 percent slopes, 1,200 feet east and 515 feet south of the northwest corner of sec. 19, T. 157 N., R. 62 W.

A—0 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; mildly alkaline; clear wavy boundary.

Bt1—11 to 17 inches; black (10YR 2/1) silty clay, gray (10YR 5/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; neutral; clear wavy boundary.

Bt2—17 to 32 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to strong fine and medium blocky; very hard, firm, very sticky and plastic; few thin clay films on faces of peds; neutral; clear wavy boundary.

Cg1—32 to 50 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/1) dry; common fine and medium prominent light olive brown (2.5Y 5/6 and 5/4) mottles; weak coarse prismatic structure parting to moderate very fine and fine subangular blocky; very hard, very firm, sticky and plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—50 to 60 inches; olive gray (5Y 5/2) laminated silty clay and silty clay loam, light gray (5Y 7/1) dry; many medium and large prominent light olive brown (2.5Y 5/6) and few fine prominent dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm, sticky and plastic; strong effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The thickness of the mollic epipedon ranges from 24 to 40 inches. The depth to carbonates ranges from 32 to 50 inches. Some pedons have an E horizon, which is 1 to 4 inches thick. Some pedons have weak platy structure in the lower part of the A horizon and have a mottled Bt horizon. The Bt horizon is silty clay loam or silty clay.

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained soils on glacial outwash plains. These soils formed in medium textured and moderately coarse textured alluvium over coarse textured glacial outwash. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 0 to 3 percent.

Renshaw soils are commonly adjacent to Barnes, Divide, Sioux, and Svea soils. Barnes and Svea soils have a clay loam or loam substratum. Barnes soils are well drained, and Svea soils are moderately well drained. Divide soils are somewhat poorly drained and have a layer of lime accumulation within a depth of 16 inches. Sioux soils contain more sand and gravel than the Renshaw soils. Divide soils are lower on the landscape than the Renshaw soils, and Sioux soils are higher. Barnes

and Svea soils are in positions on the landscape similar to those of the Renshaw soils.

Typical pedon of Renshaw loam, 1 to 3 percent slopes, 1,120 feet north and 105 feet west of the southeast corner of sec. 3, T. 151 N., R. 62 W.

A—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; few pebbles; neutral; clear wavy boundary.

Bw1—6 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; few pebbles; neutral; gradual wavy boundary.

Bw2—11 to 14 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, nonsticky and nonplastic; few pebbles; neutral; clear wavy boundary.

Bw3—14 to 17 inches; dark yellowish brown (10YR 3/4) sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; loose, nonsticky and nonplastic; about 10 percent gravel; mildly alkaline; clear wavy boundary.

2Bk—17 to 24 inches; brown (10YR 4/3) gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; lime disseminated throughout and coatings on undersides of pebbles; slight effervescence; mildly alkaline; clear wavy boundary.

2C—24 to 60 inches; dark yellowish brown (10YR 4/4) gravelly sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; slight effervescence; mildly alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The mollic epipedon ranges from 10 to 16 inches in thickness. The content of gravel in the 2C horizon ranges from 20 to 50 percent.

Sioux Series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on glacial outwash plains and till plains. These soils formed in medium textured and coarse textured glacial outwash. Slope ranges from 1 to 15 percent.

Sioux soils are commonly adjacent to Arvilla, Barnes, Buse, Renshaw, and Svea soils. Arvilla and Renshaw soils are more than 14 inches deep to sand and gravel and have a Bw horizon. Barnes, Buse, and Svea soils contain more clay and less sand and gravel than the Sioux soils. All the adjacent soils are lower on the landscape than the Sioux soils.

Typical pedon of Sioux loam, in an area of Svea-Sioux loams, 1 to 9 percent slopes, 285 feet south and 270 feet east of the northwest corner of sec. 15, T. 154 N., R. 63 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strong effervescence; mildly alkaline; abrupt smooth boundary.

AC—7 to 9 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; about 10 percent gravel; strong effervescence; mildly alkaline; clear wavy boundary.

C—9 to 60 inches; brown (10YR 4/3) very gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 50 percent gravel; carbonate coatings on undersides of pebbles; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 12 inches in thickness. The content of gravel in the C horizon ranges from 35 to 70 percent. The AC horizon is loam, gravelly loam, or loamy sand.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on glacial till plains and lake plains. These soils formed in moderately fine textured and fine textured alluvium derived from glacial till and lacustrine sediments. Slope is 0 to 1 percent.

Southam soils are commonly adjacent to Hamerly and Vallers soils. Hamerly soils are somewhat poorly drained, and Vallers soils are poorly drained. Both of these soils have a layer of lime accumulation within a depth of 16 inches. They are higher on the landscape than the Southam soils.

Typical pedon of Southam silty clay loam, 2,450 feet north and 1,050 feet west of the southeast corner of sec. 6, T. 153 N., R. 61 W.

Ag1—0 to 16 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; massive; very hard, firm, sticky and plastic; common fine snail shell fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Ag2—16 to 26 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; few fine prominent olive brown (2.5Y 4/4) mottles; massive; very hard, firm, sticky and plastic; common fine snail shell fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Ag3—26 to 32 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; few fine prominent olive brown

(2.5Y 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Ag4—32 to 40 inches; black (5Y 2/1 and 2/2) silty clay, dark gray (5Y 4/1) and olive gray (5Y 4/2) dry; few fine prominent olive brown (2.5Y 4/4) mottles; massive; extremely hard, very firm, very sticky and very plastic; common fine snail shell fragments; common fine concentrations of gypsum in nests and along planes; slight effervescence; moderately alkaline; gradual wavy boundary.

Cg1—40 to 48 inches; very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish red (5YR 4/6) and few fine distinct olive brown (2.5Y 4/4) mottles; massive; extremely hard, very firm, very sticky and very plastic; common fine snail shell fragments; few fine rounded manganese concretions; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—48 to 54 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; many fine and medium distinct olive brown (2.5Y 4/4), few medium prominent yellowish red (5YR 4/6), and few medium distinct light gray (N 7/0) mottles; massive; extremely hard, very firm, very sticky and very plastic; common fine snail shell fragments; common fine rounded manganese concretions; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg3—54 to 60 inches; dark grayish brown (2.5Y 4/2) and light gray (N 7/0) silty clay, light gray (2.5Y 7/2) and white (2.5Y 8/2) dry; common medium prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; massive; extremely hard, very firm, very sticky and very plastic; common fine snail shell fragments; few fine rounded manganese concretions; common fine concentrations of gypsum in nests and along planes; strong effervescence; moderately alkaline.

The content of clay in the 10- to 40-inch control section ranges from 35 to 50 percent. Some pedons have an O horizon, which is as much as 4 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. Some pedons have a 2A or AC horizon, or both. The C horizon has hue of 2.5Y, 5Y, or 5GY or is neutral in hue. It has value of 3 to 7 (4 to 8 dry) and chroma of 0 to 2. It typically is silty clay, but the range includes silty clay loam, clay loam, and clay. Some pedons have a 2C horizon.

Svea Series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 1 to 6 percent.

Svea soils are commonly adjacent to Barnes, Buse, Cresbard, Hamerly, and Sioux soils. Barnes and Buse soils have a mollic epipedon that is thinner than that of the Svea soils. Cresbard soils have an alkali (sodic) layer in the subsoil or substratum. Hamerly soils have a layer of lime accumulation within a depth of 16 inches and are somewhat poorly drained. Sioux soils contain more sand and gravel than the Svea soils. Barnes, Buse, and Sioux soils are higher on the landscape than the Svea soils, and Cresbard and Hamerly soils are lower.

Typical pedon of Svea loam, in an area of Barnes-Svea loams, 3 to 6 percent slopes, 1,745 feet west and 235 feet south of the northeast corner of sec. 1, T. 154 N., R. 66 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; few pebbles; mildly alkaline; abrupt smooth boundary.

Bw—8 to 17 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, friable, sticky and plastic; few pebbles; mildly alkaline; clear wavy boundary.

Bk1—17 to 21 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak coarse subangular blocky structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; lime disseminated throughout; violent effervescence; mildly alkaline; clear wavy boundary.

Bk2—21 to 32 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) dry; moderate coarse subangular blocky structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; few nests of gypsum crystals; lime disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

BCk—32 to 43 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish red (2.5YR 4/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 3 percent gravel; lime disseminated throughout with few fine nests of rounded soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—43 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; about 3 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 47 inches. The mollic epipedon ranges from 16 to 28 inches in thickness.

The Ap horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1. The A horizon ranges from 8 to 20 inches in thickness. The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. It is loam or clay loam and ranges from 8 to 16 inches in thickness. The C horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4. It is loam or clay loam. Some pedons have a sandy, gravelly, or stony layer in the lower part of the solum.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on glacial till plains and lake plains. These soils formed in moderately fine textured and medium textured local alluvium derived from glacial till or lacustrine sediments. Slope is 0 to 1 percent.

Tonka soils are commonly adjacent to Hamerly, Parnell, and Vallers soils. Hamerly and Vallers soils have a layer of lime accumulation within a depth of 16 inches. Parnell soils do not have a light colored subsurface layer. Hamerly and Vallers soils are higher on the landscape than the Tonka soils, and Parnell soils are lower.

Typical pedon of Tonka silt loam, 2,480 feet east and 120 feet north of the southwest corner of sec. 30, T. 154 N., R. 65 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

A—6 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; slightly acid; abrupt wavy boundary.

E—9 to 16 inches; dark gray (10YR 4/1) loam, light gray (10YR 7/1) dry; few fine prominent yellowish brown (10YR 5/6) mottles; moderate thin platy structure parting to moderate fine subangular blocky; soft, friable, slightly sticky and slightly plastic; slightly acid; abrupt irregular boundary.

Bt1—16 to 22 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; few fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; few silt coatings and thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

Bt2—22 to 35 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate coarse prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

BC—35 to 40 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent yellowish red (5YR 5/8) and common fine faint light gray (2.5Y 7/2) mottles; moderate fine blocky structure; hard, firm, sticky and plastic; about 3 percent gravel; strong effervescence; mildly alkaline; clear wavy boundary.

C1—40 to 54 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine prominent strong brown (7.5YR 5/6) and common medium faint light gray (2.5Y 7/2) mottles; massive; very hard, firm, sticky and plastic; few pebbles; strong effervescence; mildly alkaline; clear wavy boundary.

C2—54 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; many fine distinct brownish yellow (10YR 6/6) and common medium distinct gray (10YR 5/1) mottles; massive; very hard, firm, sticky and plastic; few manganese coatings; strong effervescence; mildly alkaline.

The Ap horizon is silt loam or loam. The E horizon ranges from 4 to 18 inches in thickness. The Bt horizon is silty clay or silty clay loam. The content of gravel in the C horizon ranges from 0 to 10 percent. This horizon is loam, clay loam, or silty clay loam.

Towner Series

The Towner series consists of deep, moderately well drained soils on glacial till plains and lake plains. These soils formed in wind- or water-deposited, moderately coarse textured and coarse textured material over medium textured and moderately fine textured glacial till or lacustrine sediments. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 1 to 6 percent.

Towner soils are commonly adjacent to Lallie, Mauvais, Svea, and Wamduska soils. Lallie and Mauvais soils contain more clay in the upper part than the Towner soils. Lallie soils are poorly drained, and Mauvais soils are somewhat poorly drained. Svea soils contain more clay and less sand in the upper part than the Towner soils. Wamduska soils have a surface layer that is thinner than that of the Towner soils. The lower part of their substratum is sand. Wamduska soils are higher on the landscape than the Towner soils, and Lallie and Mauvais soils are lower. Svea soils are in positions on the landscape similar to those of the Towner soils.

Typical pedon of Towner sandy loam, 1 to 6 percent slopes, 80 feet west and 70 feet north of the southeast corner of sec. 17, T. 153 N., R. 64 W.

A1—0 to 7 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium granular

structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; neutral; clear wavy boundary.

A2—7 to 23 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; common very fine roots; few pebbles; mildly alkaline; abrupt smooth boundary.

2C1—23 to 34 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few pebbles; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C2—34 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) and common medium faint light gray (2.5Y 7/2) mottles; massive; hard, firm, sticky and plastic; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C3—44 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; many medium and large distinct dark yellowish brown (10YR 4/4), many medium and large prominent gray (10YR 5/1), and few fine prominent strong brown (7.5YR 5/6) mottles; massive; hard, firm, sticky and plastic; few pebbles; strong effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. This horizon is loam, clay loam, silt loam, or silty clay loam. In some pedons a stony or gravelly layer is at the boundary between the A2 and 2C horizons.

Vallers Series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in medium textured and moderately fine textured glacial till. Slope ranges from 0 to 3 percent.

Vallers soils are commonly adjacent to Hamerly, Parnell, and Tonka soils. Hamerly soils are somewhat poorly drained and have olive brown colors in the substratum. Parnell and Tonka soils have a layer of clay accumulation in the subsoil. Also, Tonka soils have a light colored subsurface layer. Parnell and Tonka soils are lower on the landscape than the Vallers soils, and Hamerly soils are higher.

Typical pedon of Vallers loam, 90 feet east and 395 feet south of the northwest corner of sec. 6, T. 153 N., R. 64 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; few pebbles; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bkg1—8 to 12 inches; gray (5Y 5/1) clay loam, light gray (5Y 6/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few pebbles; lime disseminated throughout; violent effervescence; mildly alkaline; gradual wavy boundary.

Bkg2—12 to 20 inches; gray (5Y 6/1) loam, light gray (5Y 7/1) dry; few fine prominent light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; slightly hard, very friable, sticky and plastic; about 3 percent gravel; lime disseminated throughout; violent effervescence; mildly alkaline; gradual wavy boundary.

Cg1—20 to 28 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; hard, friable, sticky and plastic; about 3 percent gravel; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—28 to 34 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) and common medium distinct light yellowish brown (2.5Y 6/4) mottles; weak medium subangular blocky structure in the upper part and massive in the lower part; hard, friable, sticky and plastic; strong effervescence; about 3 percent gravel; moderately alkaline; gradual wavy boundary.

Cg3—34 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium and large prominent red (2.5YR 5/8), common medium prominent yellowish brown (10YR 5/6), and common medium distinct gray (5Y 5/1) mottles; massive; hard, friable, sticky and plastic; strong effervescence; about 3 percent gravel; moderately alkaline.

Some pedons contain gypsum in the C horizon. Some have a loam or clay loam ACk horizon. Some are saline.

Wamduska Series

The Wamduska series consists of deep, excessively drained, rapidly permeable soils on lake beaches. These soils formed in coarse textured water-sorted sediments. Slope ranges from 1 to 9 percent.

Wamduska soils are commonly adjacent to Lallie, Mauvais, and Minnewaukan soils. They are higher on the landscape than those soils. Lallie and Minnewaukan soils are poorly drained, and Mauvais soils are somewhat poorly drained.

Typical pedon of Wamduska loamy sand, 1 to 9 percent slopes, 365 feet north and 50 feet east of the southwest corner of sec. 18, T. 153 N., R. 65 W.

A—0 to 3 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; loose, nonsticky and nonplastic; about 10 percent gravel; mildly alkaline; abrupt smooth boundary.

C1—3 to 6 inches; olive brown (2.5Y 4/4) very gravelly sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 40 percent gravel; moderately alkaline; abrupt smooth boundary.

C2—6 to 16 inches; grayish brown (2.5Y 5/2) very gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; mildly alkaline; abrupt smooth boundary.

C3—16 to 24 inches; light brownish gray (2.5Y 6/2) sand, light gray (2.5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; neutral; abrupt smooth boundary.

C4—24 to 32 inches; grayish brown (2.5Y 5/2) coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; neutral; abrupt smooth boundary.

C5—32 to 42 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; mildly alkaline; abrupt smooth boundary.

C6—42 to 50 inches; light brownish gray (2.5Y 6/2) gravelly sand, light gray (2.5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

C7—50 to 60 inches; dark grayish brown (2.5Y 4/2) sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; about 10 percent gravel; slight effervescence; moderately alkaline.

The A horizon is 3 to 6 inches thick. The content of gravel in the C horizon ranges from 15 to 25 percent. It is more than 35 percent in individual horizons. The C horizon has value of 3 to 6 (4 to 7 dry) and chroma of 2 to 4.

Wyrene Series

The Wyrene series consists of deep, somewhat poorly drained soils on glacial outwash plains. These soils formed in moderately coarse textured and coarse textured material over medium textured and moderately fine textured glacial outwash sediments. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slope ranges from 0 to 3 percent.

Wyrene soils are commonly adjacent to Arvilla, Bearden, and Hamerly soils. Arvilla soils are somewhat excessively drained and contain more gravel than the Wyrene soils. Also, they are higher on the landscape. Bearden and Hamerly soils contain more clay and less sand than the Wyrene soils. They are in positions on the landscape similar to those of the Wyrene soils.

Typical pedon of Wyrene sandy loam, loamy substratum, 0 to 3 percent slopes, 1,845 feet north and 90 feet west of the southeast corner of sec. 2, T. 156 N., R. 65 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; strong effervescence; about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

Bk—10 to 18 inches; dark grayish brown (10YR 4/2) sandy loam, gray (10YR 6/1) dry; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky; soft, friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; lime disseminated throughout; violent effervescence; mildly alkaline; clear wavy boundary.

2C1—18 to 29 inches; pale brown (10YR 6/3) loamy sand, light gray (10YR 7/2) dry; few fine prominent yellowish red (5YR 4/6) mottles; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; about 10 percent gravel; strong effervescence; moderately alkaline; clear irregular boundary.

2C2—29 to 49 inches; light brownish gray (2.5Y 6/2) gravelly sand, light gray (2.5Y 7/2) dry; many coarse distinct yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky and nonplastic; strong effervescence; about 15 percent gravel; moderately alkaline; clear smooth boundary.

3C3—49 to 60 inches; gray (10YR 6/1) laminated loam and clay loam, white (10YR 8/1) dry; many medium prominent yellowish red (5YR 4/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The depth to the 2C horizon ranges from 17 to 24 inches. The content of gravel in the 2C horizon ranges from 5 to 25 percent. This horizon is gravelly sand, loamy sand, coarse sand, or sand. The 3C horizon is loam, clay loam, or silt loam.

Zell Series

The Zell series consists of deep, well drained, moderately permeable soils on glacial till plains and lake plains. These soils formed in medium textured glaciolacustrine sediments. Slope ranges from 3 to 9 percent.

Zell soils are commonly adjacent to Buse, Maddock, and Sioux soils. The sand in the adjacent soils is coarser than that in the Zell soils. Buse soils contain more clay than the Zell soils, and Maddock and Sioux soils contain more sand. Sioux soils are generally higher on the landscape than the Zell soils. Buse and Maddock soils are in

positions on the landscape similar to those of the Zell soils.

Typical pedon of Zell loam, in an area of Zell-Maddock complex, 3 to 9 percent slopes, 2,150 feet north and 20 feet east of the southwest corner of sec. 5, T. 153 N., R. 61 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft, very friable, nonsticky and slightly plastic; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bw—6 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure parting to weak fine subangular blocky; soft, very friable, nonsticky and slightly plastic; strong effervescence; moderately alkaline; clear irregular boundary.

BCk—10 to 16 inches; olive brown (2.5Y 4/4) silt loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and slightly plastic; lime disseminated throughout with some soft nests and threads; violent effervescence; moderately alkaline; clear wavy boundary.

C1—16 to 36 inches; olive brown (2.5Y 4/4) silt loam, light gray (2.5Y 7/2) dry; massive; soft, very friable, nonsticky and slightly plastic; violent effervescence; moderately alkaline; clear wavy boundary.

C2—36 to 60 inches; olive brown (2.5Y 4/4) laminated silt loam and very fine sandy loam, light gray (2.5Y 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 6 to 10 inches in thickness. The BCk horizon ranges from 6 to 20 inches in thickness.

Formation of the Soils

Soil forms through processes acting on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in Ramsey County formed in glacial drift. The advancing glacier picked up rocks and soil, ground and mixed them, and deposited the material as the ice melted from the receding glacier. Some soils, such as Barnes and Svea, formed in unsorted material, or glacial till. Some soils, such as Hegne and Aberdeen, formed in glaciolacustrine deposits, or glacial material deposited by water in glacial lakes. Other soils, such as Sioux and Towner, formed in glacial outwash, or material deposited by glacial meltwater.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of soil material. The climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soil.

In addition to weathering soil material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Freezing and thawing help to break down soil particles in the parent material, thereby providing more surface area for chemical processes. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Ramsey County has a continental, semiarid climate characterized by long, cold winters and short, warm summers. Most of the precipitation falls during the growing season and is distributed in an erratic pattern. The climate is fairly uniform throughout the county.

Slight climatic fluctuations since the glaciers receded have caused fluctuations in the water level of Devils Lake. Such soils as Lallie and Mauvais are young soils alternately exposed and inundated by the fluctuating lake levels.

Plant and Animal Life

The soils in Ramsey County formed mainly under grassland vegetation. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soil. The fibrous roots of these grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result of these changes in the soil, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of the plants improves the available water capacity, tilth, and fertility of the soil. The decayed organic matter, accumulating over long periods, gives the surface layer its dark color.

Bottineau soils, which are primarily in areas bordering Devils Lake, formed under woodland vegetation. These areas were subject to a greater amount of leaching than other areas. The leaching has resulted in the removal of clay from the surface layer and the subsequent accumulation in the subsoil.

Micro-organisms have important effects on soil formation because they feed on undecomposed organic matter and convert it into humus from which plants can obtain nutrients for increased growth. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soil.

Human activities greatly affect soil formation. Management measures can alter soil drainage. They can help to control erosion, thus maintaining fertility. Poor management can increase the susceptibility to erosion and thus result in an unproductive soil.

Relief

The slope of the soils in Ramsey County ranges from level to very steep. The degree of slope and the shape of the surface affect each soil through their effects on runoff and internal drainage.

On Buse and other soils in areas where slopes are steep, most of the precipitation is lost as runoff. Vegetation is sparse, leaching is restricted, and profile development is slow. Svea and other soils in the lower areas receive more moisture because of their position on the landscape. As a result, plant growth, leaching, and the extent of profile development are increased.

Soils formed in depressions vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternate wet and dry cycles that occur in the depressions. Southam soils, which are in deep depressions, are continuously wet and have a very thick surface layer. The horizonation in these soils is a result of sedimentary processes rather than soil-forming processes (*4*).

Time

The formation of a soil is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil profile. Approximately 10,000 years have passed since the glacier receded from Ramsey County. In geologic terms, the soils in the county are young.

More time has been available for the formation of Svea soils on glacial till plains than for the formation of Lallie soils on lake plains adjacent to Devils Lake. The forces of soil formation have been continually acting on the parent material of Svea soils; however, Lallie soils were recently exposed as a result of the receding waters of Devils Lake. Svea soils have well defined horizons and a high organic matter content, whereas Lallie soils do not have distinct horizons and have a low organic matter content.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vols., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Arnold, R. W. Clean brush approach achieves better concepts. —Unpublished report

(4) Bigler, Ricky Jerome. 1981. The correlation of soil morphology and taxonomic units with wetland plant communities. M.S. Thesis, N. Dakota State Univ. of Agric. and Appl. Sci., 121 pp., illus.

(5) Devils Lake Bicentennial Committee. 1976. A bicentennial history of Devils Lake, North Dakota. 96 pp., illus.

(6) Hutchinson, R. D. 1977. Ground-water basic data for Ramsey County, North Dakota. U.S. Geol. Surv. Bull. 71, Part II, 344 pp., illus.

(7) Hutchinson, R. D., and Robert L. Klausing. 1980. Ground-water resources of Ramsey County, North Dakota. U.S. Geol. Surv. Bull. 71, Part III, 36 pp., illus.

(8) Kotchman, Larry A. 1980. Forest inventory report for north central resource conservation and development area. 41 pp., illus.

(9) Libby, O. G., ed. 1906-25. North Dakota state historical society: Collection of the state historical society. Vols. 1-7.

(10) Meier, Ben, North Dakota Secretary of State. Population—North Dakota. —Individual sheet issued in 1981

(11) Omodt, H. W., G. A. Johnsgard, D. D. Patterson, and O. P. Olson. 1968. The major soils of North Dakota. N. Dak. Agric. Exp. Stn. Bull. 472, 60 pp., illus.

(12) Robinson, Elwyn B. 1966. History of North Dakota. 599 pp., illus.

(13) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(14) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(15) United States Department of Commerce, Bureau of the Census. 1981. 1978 census of agriculture—North Dakota state and county data. Vol. 1, Part 34.

Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse textured soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. The E horizon.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 9 inches (10 to 23 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. An A horizon 10 inches or more thick. It includes all subdivisions of this horizon.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-80 at Devils Lake, North Dakota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	^oF	^oF	^oF	^oF	^oF	Units	In	In	In		In
January----	12.5	-6.4	3.1	42	-33	0	0.57	0.25	0.84	3	7.7
February---	20.4	.6	10.5	47	-27	0	.45	.17	.68	2	5.0
March------	31.3	12.2	21.8	61	-22	31	.78	.29	1.17	3	8.3
April------	50.4	29.6	40.0	84	5	143	.98	.33	1.51	3	2.8
May--------	65.6	41.7	53.7	91	22	434	2.17	.87	3.26	6	.4
June-------	74.9	52.3	63.6	96	36	708	3.35	1.83	4.68	7	.0
July-------	81.2	57.0	69.1	99	43	902	2.18	1.16	3.08	5	.0
August-----	79.7	54.4	67.1	99	38	840	2.12	1.00	3.07	5	.0
September--	67.6	43.5	55.6	95	25	468	1.90	.67	2.91	5	.0
October----	55.9	33.6	44.8	85	15	212	.90	.26	1.40	3	1.1
November---	35.0	18.2	26.6	64	-11	23	.63	.16	.99	2	5.0
December---	20.6	3.1	11.9	48	-28	0	.55	.22	.82	2	6.9
Yearly:											
Average--	49.6	28.9	39.0	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	-33	---	---	---	---	---	---
Total----	---	---	---	---	---	3,761	16.58	13.74	19.28	46	37.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-80 at Devils Lake, North Dakota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 10	May 22	May 31
2 years in 10 later than--	May 5	May 17	May 26
5 years in 10 later than--	Apr. 24	May 6	May 17
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 25	Sept. 13	Sept. 9
2 years in 10 earlier than--	Sept. 30	Sept. 19	Sept. 13
5 years in 10 earlier than--	Oct. 11	Sept. 30	Sept. 21

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-80 at Devils Lake, North Dakota]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	146	120	110
8 years in 10	154	129	115
5 years in 10	170	147	126
2 years in 10	185	164	136
1 year in 10	193	173	141

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Tonka silt loam	4,440	0.5
2	Parnell silty clay loam	26,180	3.1
4	Southam silty clay loam	20,220	2.4
5	Grano silty clay	3,770	0.5
7	Fargo silty clay	2,075	0.2
8	Colvin silty clay loam, wet	2,120	0.3
11	Svea-Barnes loams, 1 to 3 percent slopes	33,570	4.0
12B	Barnes-Svea loams, 3 to 6 percent slopes	55,965	6.7
13C	Barnes-Buse loams, 6 to 9 percent slopes	37,840	4.5
13D	Barnes-Buse loams, 9 to 15 percent slopes	6,895	0.8
14C	Svea-Sioux loams, 1 to 9 percent slopes	12,685	1.5
15C	Esmond-Emrick loams, 3 to 9 percent slopes	2,515	0.3
16E	Langhei-Barnes loams, 9 to 40 percent slopes	3,035	0.4
17D	Sioux-Buse loams, 9 to 15 percent slopes	6,895	0.8
19B	Svea-Buse loams, 3 to 6 percent slopes	74,530	8.9
20	Hamerly-Svea loams, 1 to 3 percent slopes	122,205	14.6
20B	Hamerly-Svea loams, 3 to 6 percent slopes	30,540	3.6
21	Vallers-Hamerly loams, saline, 0 to 3 percent slopes	75,555	9.0
22	Vallers loam	7,865	0.9
23	Hamerly-Cresbard loams, 1 to 3 percent slopes	75,445	9.0
24	Svea-Cresbard loams, 1 to 3 percent slopes	6,950	0.8
24B	Barnes-Cresbard loams, 3 to 6 percent slopes	9,400	1.1
26	Vallers-Parnell-Tonka complex, 0 to 3 percent slopes	28,135	3.4
28C	Zell-Maddock complex, 3 to 9 percent slopes	2,250	0.3
30	Embden loam, 0 to 3 percent slopes	790	0.1
31	Svea loam, 1 to 3 percent slopes	3,900	0.5
32	Glyndon silt loam, 0 to 3 percent slopes	855	0.1
34	Aberdeen silt loam	6,430	0.8
35	Overly silty clay loam, 0 to 3 percent slopes	2,765	0.3
36	Bearden silty clay loam	10,120	1.2
38	Colvin silty clay loam, saline	9,610	1.1
39	Colvin silty clay loam	4,945	0.6
40	Colvin-Aberdeen silty clay loams	3,785	0.5
42	Fargo-Hegne silty clays	23,385	2.8
44	Hegne silty clay, saline	6,890	0.8
45	Hegne silty clay	9,010	1.1
46	Aberdeen-Fargo silty clay loams	3,865	0.5
50B	Towner sandy loam, 1 to 6 percent slopes	1,870	0.2
52	Wyrene sandy loam, loamy substratum, 0 to 3 percent slopes	1,440	0.2
53	Renshaw loam, 1 to 3 percent slopes	2,495	0.3
54B	Arvilla sandy loam, 1 to 6 percent slopes	2,310	0.3
56	Hamerly-Renshaw loams, 0 to 3 percent slopes	2,535	0.3
57C	Sioux loam, 1 to 9 percent slopes	1,085	0.1
58	Divide loam, loamy substratum, 1 to 3 percent slopes	3,355	0.4
65	Ojata clay loam	990	0.1
70	Lallie clay loam	3,805	0.5
75	Lallie clay loam, saline	1,720	0.2
77	Minnewaukan loamy fine sand, 1 to 3 percent slopes	720	0.1
78C	Wamduska loamy sand, 1 to 9 percent slopes	3,205	0.4
81B	Mauvais loam, 0 to 6 percent slopes	4,785	0.6
83B	Great Bend-Overly silty clay loams, 3 to 6 percent slopes	755	0.1
84	Bottineau loam, 1 to 3 percent slopes	890	0.1
84B	Bottineau loam, 3 to 6 percent slopes	1,025	0.1
	Water	67,345	8.0
	Total	837,760	100.0

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
1	Tonka silt loam (where drained)
7	Fargo silty clay (where drained)
11	Svea-Barnes loams, 1 to 3 percent slopes
12B	Barnes-Svea loams, 3 to 6 percent slopes
19B	Svea-Buse loams, 3 to 6 percent slopes
20	Hamerly-Svea loams, 1 to 3 percent slopes
20B	Hamerly-Svea loams, 3 to 6 percent slopes
22	Vallers loam (where drained)
30	Embden loam, 0 to 3 percent slopes
31	Svea loam, 1 to 3 percent slopes
32	Glyndon silt loam, 0 to 3 percent slopes
35	Overly silty clay loam, 0 to 3 percent slopes
36	Bearden silty clay loam
39	Colvin silty clay loam (where drained)
42	Fargo-Hegne silty clays (where drained)
45	Hegne silty clay (where drained)
58	Divide loam, loamy substratum, 1 to 3 percent slopes
83B	Great Bend-Overly silty clay loams, 3 to 6 percent slopes
84	Bottineau loam, 1 to 3 percent slopes
84B	Bottineau loam, 3 to 6 percent slopes

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Sunflowers	Spring wheat	Barley	Flax	Bromegrass-alfalfa hay
	Lbs	Bu	Bu	Bu	Tons
1*----------------------- Tonka	650	16	26	8	1.3
2----------------------- Parnell	---	---	---	---	---
4----------------------- Southam	---	---	---	---	---
5*----------------------- Grano	800	20	32	10	1.6
7----------------------- Fargo	1,450	36	58	18	2.9
8----------------------- Colvin	---	---	---	---	---
11----------------------- Svea-Barnes	1,450	36	58	18	2.9
12B----------------------- Barnes-Svea	1,300	32	52	16	2.6
13C----------------------- Barnes-Buse	900	22	36	11	1.8
13D----------------------- Barnes-Buse	700	18	28	8	1.4
14C----------------------- Svea-Sioux	900	22	36	11	1.8
15C----------------------- Esmond-Emrick	950	24	39	12	2.0
16E----------------------- Langhei-Barnes	---	---	---	---	---
17D----------------------- Sioux-Buse	---	---	---	---	1.0
19B----------------------- Svea-Buse	1,100	28	45	14	2.3
20----------------------- Hamerly-Svea	1,350	34	55	17	2.8
20B----------------------- Hamerly-Svea	1,200	30	49	15	2.4
21----------------------- Vallers-Hamerly	800	20	32	10	1.6
22----------------------- Vallers	1,100	28	46	14	2.3
23----------------------- Hamerly-Cresbard	1,300	32	52	16	2.6

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Sunflowers	Spring wheat	Barley	Flax	Bromegrass-alfalfa hay
	Lbs	Bu	Bu	Bu	Tons
24 Svea-Cresbard	1,300	32	52	16	2.6
24B Barnes-Cresbard	1,200	30	49	15	2.4
26* Vallers-Parnell-Tonka	800	20	32	10	1.6
28C Zell-Maddock	700	18	29	9	1.5
30 Embden	1,300	32	52	16	2.6
31 Svea	1,450	36	58	18	2.9
32 Glyndon	1,500	38	62	19	3.1
34 Aberdeen	1,300	32	52	16	2.6
35 Overly	1,500	38	62	19	3.1
36 Bearden	1,450	36	58	18	2.9
38 Colvin	700	18	29	9	1.5
39* Colvin	800	20	32	10	1.6
40 Colvin-Aberdeen	1,050	26	42	13	2.1
42 Fargo-Hegne	1,350	34	55	17	2.8
44 Hegne	900	22	36	11	1.8
45 Hegne	1,200	30	49	15	2.4
46 Aberdeen-Fargo	1,350	34	55	17	2.8
50B Towner	950	24	39	12	2.0
52 Wyrene	900	22	36	11	1.8
53 Renshaw	700	18	29	9	1.5
54B Arvilla	700	18	29	9	1.5

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Sunflowers	Spring wheat	Barley	Flax	Bromegrass-alfalfa hay
	Lbs	Bu	Bu	Bu	Tons
56------------------------ Hamerly-Renshaw	1,100	28	46	14	2.3
57C----------------------- Sioux	---	---	---	---	1.0
58------------------------ Divide	950	24	39	12	2.0
65------------------------ Ojata	---	---	---	---	---
70------------------------ Lallie	400	10	16	5	0.8
75------------------------ Lallie	---	---	---	---	0.5
77------------------------ Minnewaukan	400	10	16	5	0.8
78C----------------------- Wamduska	---	---	---	---	---
81B----------------------- Mauvais	500	12	20	6	1.0
83B----------------------- Great Bend-Overly	1,300	32	52	16	2.6
84------------------------ Bottineau	1,450	36	58	18	2.9
84B----------------------- Bottineau	1,350	34	55	17	2.8

* Yields are for undrained areas.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1. Tonka					
2. Parnell					
4. Southam					
5. Grano					
7. Fargo	American plum	Eastern redcedar, lilac, common chokecherry, redosier dogwood, Siberian peashrub, Tatarian honeysuckle.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
8. Colvin					
11*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
12B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
13C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
13D*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse.					
14C*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Sioux.					
15C*:					
Esmond	Siberian peashrub, Tatarian honeysuckle.	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
Emrick	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
16E*:					
Langhei	Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
Barnes.					
17D*:					
Sioux.					
Buse.					
19B*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Buse	Siberian peashrub, Tatarian honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
20*, 20B*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
21*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
21*:					
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
22 Vallers	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
23*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry; Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
24*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
24B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Cresbard	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
26*:					
Vallers	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
Parnell	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Tatarian honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
28C*:					
Zell	Tatarian honeysuckle, Siberian peashrub, lilac, skunkbush sumac, silver buffaloberry, Peking cotoneaster.	Ponderosa pine, Russian-olive, green ash, Rocky Mountain juniper, eastern redcedar.	Siberian elm	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
28C*:					
Maddock	---	Lilac, silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
30. Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
31. Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
32. Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
34. Aberdeen	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
35: Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
36: Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
38: Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
39: Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood, Tatarian honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
40*:					
Colvin	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
Aberdeen	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
42*:					
Fargo	American plum	Eastern redcedar, lilac, common chokecherry, redosier dogwood, Siberian peashrub, Tatarian honeysuckle.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
42*:					
Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
44 Hegne	Siberian peashrub, silver buffaloberry.	---	Green ash, Russian-olive, Siberian elm.	---	---
45 Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
46*:					
Aberdeen	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Fargo.					
50B Towner	---	Eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
52 Wyrene	---	Tatarian honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
53 Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
54B Arvilla	Tatarian honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
56*: Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Renshaw	Silver buffaloberry, Tatarian honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
57C. Sioux					
58 Divide	---	Peking cotoneaster, redosier dogwood, American plum, Siberian peashrub, Tatarian honeysuckle, eastern redcedar, common chokecherry, ponderosa pine.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
65. Ojata					
70 Lallie	American plum	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
75. Lallie					

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
77. Minnewaukan	American plum	Lilac, Tatarian honeysuckle, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
78C. Wamduska					
81B. Mauvais	---	Russian-olive, common chokecherry, eastern redcedar, lilac, silver buffaloberry, Siberian peashrub, Tatarian honeysuckle, Peking cotoneaster.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
83B*: Great Bend	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, American plum, common chokecherry.	Green ash, bur oak, ponderosa pine, Black Hills spruce, Russian-olive, Siberian crabapple.	---	---
Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
84, 84B. Bottineau	---	Lilac, eastern redcedar, redosier dogwood, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian-olive.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
2 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
4 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
5 Grano	Severe: flooding, ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
7 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
8 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
11*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Barnes	Slight	Slight	Moderate: slope.	Slight.
12B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
13C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
13D*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
14C*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
15C*:				
Esmond	Slight	Slight	Severe: slope.	Slight.
Emrick	Slight	Slight	Severe: slope.	Slight.
16E*:				
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
17D*:				
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
19B*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
20*, 20B*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
21*:				
Vallers	Severe: wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
22 Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
23*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
24*:				
Svea	Slight	Slight	Moderate: slope.	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
24*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
24B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
26*:				
Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
28C*:				
Zell	Slight	Slight	Severe: slope.	Slight.
Maddock	Slight	Slight	Severe: slope.	Slight.
30 Embden	Slight	Slight	Slight	Slight.
31 Svea	Slight	Slight	Moderate: slope.	Slight.
32 Glyndon	Slight	Slight	Slight	Slight.
34 Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
35 Overly	Slight	Slight	Slight	Slight.
36 Bearden	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight.
38 Colvin	Severe: flooding, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
39 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
40*:				
Colvin	Severe: flooding, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
42*:				
Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Hegne	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
44 Hegne	Severe: flooding, ponding, too clayey.	Severe: ponding, too clayey, excess humus.	Severe: too clayey, excess humus, ponding.	Severe: ponding, too clayey, excess humus.
45 Hegne	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
46*:				
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Fargo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
50B Towner	Slight	Slight	Moderate: slope.	Slight.
52 Wyrene	Slight	Slight	Moderate: small stones.	Slight.
53 Renshaw	Slight	Slight	Moderate: slope.	Slight.
54B Arvilla	Slight	Slight	Moderate: slope.	Slight.
56*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Renshaw	Slight	Slight	Slight	Slight.
57C Sioux	Slight	Slight	Moderate: slope, small stones.	Slight.
58 Divide	Slight	Slight	Moderate: slope.	Slight.
65 Ojata	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
70 Lallie	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness, erodes easily.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
75 Lallie	Severe: ponding, excess salt.	Severe: ponding, excess salt.	Severe: too clayey, ponding.	Severe: ponding.
77 Minnewaukan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
78C Wamduska	Slight	Slight	Moderate: slope.	Slight.
81B Mauvais	Severe: wetness.	Moderate: wetness, excess salt.	Severe: wetness.	Moderate: wetness.
83B*:				
Great Bend	Slight	Slight	Moderate: slope.	Slight.
Overly	Slight	Slight	Moderate: slope.	Slight.
84, 84B Bottineau	Slight	Slight	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
1------------------ Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
2------------------ Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
4------------------ Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
5------------------ Grano	Poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
7------------------ Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
8------------------ Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
11*:									
Svea---------------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes-------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
12B*:									
Barnes-------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea---------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
13C*:									
Barnes-------------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse---------------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
13D*:									
Barnes-------------	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Buse---------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
14C*:									
Svea---------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Sioux--------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
15C*:									
Esmond-------------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick-------------	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
16E*:									
Langhei------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes-------------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
17D*:									
Sioux--------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Buse---------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
19B*:									
Svea---------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
19B*:									
Buse	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
20*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
20B*:									
Hamerly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
21*:									
Vallers	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
22 Vallers	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
23*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
24*:									
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
24B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
26*:									
Vallers	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Parnell	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
Tonka	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
28C*:									
Zell	Poor	Fair	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Maddock	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
30 Embden	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
31 Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
32 Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
34 Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
35 Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
36 Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
38 Colvin	Fair	Fair	Poor	Fair	Good	Good	Fair	Good	Poor.
39 Colvin	Good	Good	Fair	Fair	Good	Good	Good	Good	Fair.
40*:									
Colvin	Fair	Fair	Poor	Fair	Good	Good	Fair	Good	Poor.
Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
42*:									
Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
Hegne	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
44 Hegne	Fair	Fair	Fair	Very poor	Poor	Good	Fair	Fair	Poor.
45 Hegne	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
46*:									
Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Fargo	Good	Good	Fair	Poor	Good	Good	Fair	Good	Poor.
50B Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
52 Wyrene	Fair	Good	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
53 Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
54B Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
56*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
57C Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
58 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
65 Ojata	Poor	Poor	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
70 Lallie	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor.
75 Lallie	Poor	Poor	Poor	Very poor	Poor	Good	Poor	Fair	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
77----------------- Minnewaukan	Poor	Poor	Fair	Fair	Fair	Very poor	Poor	Poor	Fair.
78C---------------- Wamduska	Poor	Poor	Poor	Good	Very poor	Very poor	Poor	Very poor	Fair.
81B---------------- Mauvais	Poor	Fair	Poor	Fair	Fair	Very poor	Poor	Poor	Poor.
83B*:									
Great Bend--------	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Overly------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
84, 84B------------ Bottineau	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1----------------- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
2----------------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
4----------------- Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
5----------------- Grano	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding, frost action.
7----------------- Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, frost action.
8----------------- Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
11*:					
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
12B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
13C*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Buse-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
13D*:					
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
14C*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
15C*:					
Esmond	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
Emrick	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.
16E*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
17D*:					
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
19B*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
20*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
20B*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: frost action.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
21*:					
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
22--------------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
23*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Cresbard---------	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
24*:					
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Cresbard---------	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
24B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Cresbard---------	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
26*:					
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Parnell----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
Tonka------------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
28C*:					
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.
Maddock	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
30 Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
31 Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
32 Glyndon	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
34 Aberdeen	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
35 Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
36 Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.
38 Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
39 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
40*:					
Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
Aberdeen	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
42*:					
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, frost action.
Hegne	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, shrink-swell.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
44 Hegne	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
45 Hegne	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, shrink-swell.
46*:					
Aberdeen	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, frost action.
50B Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
52 Wyrene	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
53 Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
54B Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
56*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Renshaw	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
57C Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
58 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
65 Ojata	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
70 Lallie	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
75 Lallie	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding, flooding.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
77 Minnewaukan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
78C Wamduska	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
81B Mauvais	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
83B*:					
Great Bend	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.
Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
84 Bottineau	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
84B Bottineau	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
4 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
5 Grano	Severe: ponding, percs slowly.	Slight	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
7 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
8 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
11*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
12B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
13C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
13D*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
14C*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
15C*:					
Esmond	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Emrick	Slight	Severe: seepage.	Severe: seepage.	Slight	Fair: thin layer.
16E*:					
Langhei	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
17D*:					
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
19B*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
20*, 20B*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
21*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
22 Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
23*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
24*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
24B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
26*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
28C*:					
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
28C*:					
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
30 Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
31 Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
32 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
34 Aberdeen	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
35 Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
36 Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
38 Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
39 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
40*:					
Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Aberdeen	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
42*:					
Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
44 Hegne	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
45------------------ Hegne	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
46*:					
Aberdeen-----------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Fargo--------------	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
50B----------------- Towner	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
52------------------ Wyrene	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
53------------------ Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
54B----------------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
56*:					
Hamerly------------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Renshaw------------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
57C----------------- Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
58------------------ Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
65------------------ Ojata	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess salt.	Severe: wetness.	Poor: wetness, excess salt.
70------------------ Lallie	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
75------------------ Lallie	Severe: flooding, ponding, percs slowly.	Severe: flooding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, hard to pack, ponding.
77------------------ Minnewaukan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
78C----------------- Wamduska	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
81B----------------- Mauvais	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
83B*:					
Great Bend---------	Severe: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
Overly-------------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Poor: thin layer.
84, 84B------------ Bottineau	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
2 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
4 Southam	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
5 Grano	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
7 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
8 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
11*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
12B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
13C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
13D*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
13D*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
14C*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
15C*:				
Esmond	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Emrick	Good	Probable	Improbable: too sandy.	Fair: small stones.
16E*:				
Langhei	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
17D*:				
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
19B*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
20*, 20B*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
21*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
21*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
22 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
23*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
24*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
24B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
26*:				
Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
28C*:				
Zell	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Maddock	Good	Probable	Improbable: too sandy.	Poor: thin layer.
30 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
31 Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
32 Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
34-------------------- Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
35-------------------- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
36-------------------- Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
38-------------------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
39-------------------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
40*:				
Colvin---------------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Aberdeen-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
42*:				
Fargo----------------	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Hegne----------------	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
44-------------------- Hegne	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
45-------------------- Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
46*:				
Aberdeen-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Fargo----------------	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
50B------------------- Towner	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
52-------------------- Wyrene	Fair: thin layer.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones.
53-------------------- Renshaw	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
54B Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
56*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
57C Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
58 Divide	Fair: wetness.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones.
65 Ojata	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
70 Lallie	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
75 Lallie	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
77 Minnewaukan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: small stones, wetness.
78C Wamduska	Good	Probable	Probable	Poor: small stones, area reclaim.
81B Mauvais	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, excess salt.
83B*:				
Great Bend	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
84, 84B Bottineau	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1: Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
2: Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
4: Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
5: Grano	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
7: Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
8: Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
11*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
12B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
13C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
13D*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
14C*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
14C*:						
Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
15C*:						
Esmond	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Emrick	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
16E*:						
Langhei	Severe: slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
17D*:						
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
19B*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
20*:						
Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
20B*:						
Hamerly	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
21*:						
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Hamerly	Moderate: seepage.	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
22 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
23*:						
Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
24*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
24B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable	Excess sodium, percs slowly.
26*:						
Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
28C*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
30 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable	Favorable	Favorable.
31 Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
32 Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
34 Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily	Excess sodium, erodes easily, percs slowly.
35 Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
36 Bearden	Moderate: seepage.	Moderate: piping, hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
38 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
39 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
40*:						
Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily	Excess sodium, erodes easily, percs slowly.
42*:						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
44 Hegne	Slight	Severe: ponding.	Ponding, percs slowly, excess salt.	Ponding, droughty, slow intake.	Ponding, percs slowly.	Wetness, excess salt, droughty.
45 Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
46*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily	Excess sodium, erodes easily, percs slowly.
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
50B Towner	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily, droughty.
52 Wyrene	Severe: seepage.	Severe: piping.	Deep to water	Droughty, soil blowing.	Soil blowing	Droughty.
53 Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
54B Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
56*:						
Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
57C: Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
58: Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
65: Ojata	Slight	Severe: piping, wetness, excess salt.	Percs slowly, frost action, excess salt.	Wetness, droughty, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, excess salt, erodes easily.
70: Lallie	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, excess salt, erodes easily.
75: Lallie	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, flooding.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
77: Minnewaukan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
78C: Wamduska	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, rooting depth.
81B: Mauvais	Moderate: slope.	Severe: piping, wetness.	Frost action, slope.	Wetness, slope.	Wetness	Wetness, excess salt.
83B*:						
Great Bend	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Overly	Moderate: slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Favorable	Percs slowly.
84: Bottineau	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
84B: Bottineau	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1----------------- Tonka	0-9	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	9-35	Silty clay loam, loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	35-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
2----------------- Parnell	0-11	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	11-32	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	32-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
4----------------- Southam	0-16	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	85-100	30-50	10-25
	16-40	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	40-60	Silty clay, silty clay loam, clay.	CL, CH	A-6, A-7	0	100	95-100	90-100	80-100	30-75	10-50
5----------------- Grano	0-14	Silty clay--------	CH	A-7	0	100	100	95-100	80-95	50-75	25-50
	14-60	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-75	25-50
7----------------- Fargo	0-7	Silty clay--------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	7-19	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	19-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
8----------------- Colvin	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	12-28	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	28-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
11*:											
Svea-------------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Barnes-----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-13	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	13-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
12B*:											
Barnes-----------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea-------------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
13C*:											
Barnes----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
13D*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	17-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
14C*:											
Svea------------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	10-31	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	31-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Sioux-----------	0-9	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	9-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
15C*:											
Esmond----------	0-8	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-60	Loam, sandy loam, loamy sand.	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
Emrick----------	0-12	Loam-------------	ML	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	12-28	Loam-------------	ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	28-50	Loam, sandy loam	ML, SM	A-4	0-5	95-100	95-100	60-100	35-90	20-40	NP-10
	50-60	Fine sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2	0-5	95-100	95-100	85-100	10-35	15-30	NP-7
16E*:											
Langhei---------	0-4	Loam-------------	CL-ML, CL	A-4, A-6	0-3	95-100	90-100	75-90	55-80	20-40	5-20
	4-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-3	95-100	90-100	75-90	60-80	20-40	5-25
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-11	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	11-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
17D*:											
Sioux-----------	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	7-10	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	10-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
19B*:											
Svea------------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	9-26	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	26-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-95	60-85	25-40	5-20
20*, 20B*:											
Hamerly---------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	7-28	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
Svea------------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
21*:											
Vallers---------	0-8	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	8-20	Clay loam--------	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly---------	0-15	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	15-28	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
22--------------- Vallers	0-8	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	8-20	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	20-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
23*:											
Hamerly---------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	6-28	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
23*:											
Cresbard	0-7	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	7-24	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	24-60	Clay loam, loam	CL, CH, ML	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
24*:											
Svea	0-8	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	8-18	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	18-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Cresbard	0-7	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	7-24	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	24-60	Clay loam, loam	CL, CH, ML	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
24B*:											
Barnes	0-9	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	9-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Cresbard	0-6	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	6-18	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	18-60	Clay loam, loam	CL, CH, ML	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
26*:											
Vallers	0-22	Loam	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	22-31	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	31-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
Parnell	0-11	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	11-32	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	32-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
Tonka	0-9	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	9-35	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	35-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
28C*:											
Zell	0-6	Loam	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	6-16	Silt loam, very fine sandy loam, loam.	CL, ML, CL-ML	A-4, A-6	0	100	95-100	85-100	70-100	25-40	5-15
	16-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML	A-4	0	100	95-100	85-100	60-100	<30	NP-7
Maddock	0-7	Fine sandy loam	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	7-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
30------------- Embden	0-19	Loam------------	ML, CL-ML, CL	A-4	0	100	100	85-95	55-70	15-35	NP-10
	19-35	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	35-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
31------------- Svea	0-9	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	9-20	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	20-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
32------------- Glyndon	0-8	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	8-30	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	30-54	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	54-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-95	20-40	5-20
34------------- Aberdeen	0-7	Silt loam--------	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-45	7-20
	7-21	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	21-40	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	40-60	Stratified silt loam to silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
35------------- Overly	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	9-24	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	24-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
36------------- Bearden	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	9-18	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	18-40	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	40-60	Silt loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-60	10-30
38------------- Colvin	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-50	15-30
	11-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
39------------- Colvin	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	11-38	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	38-60	Silt loam, silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
40*:											
Colvin----------	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-50	15-30
	7-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
Aberdeen--------	0-6	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	6-22	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	22-40	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	40-60	Stratified silt loam to silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
42*:											
Fargo-----------	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	7-20	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	20-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
Hegne-----------	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	8-45	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	45-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
44--------------- Hegne	0-15	Silty clay-------	OH, CH	A-7	0	100	100	95-100	90-98	50-70	11-30
	15-21	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	22-40
	21-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	50-75	22-45
45--------------- Hegne	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	8-45	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	45-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
46*:											
Aberdeen--------	0-6	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	6-22	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	22-40	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	40-60	Stratified silt loam to silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
Fargo-----------	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	7-19	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	19-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
50B-------------- Towner	0-7	Sandy loam-------	SM, SM-SC	A-2, A-4	0	100	100	60-85	30-45	<25	NP-5
	7-23	Loamy sand, loamy fine sand, fine sand.	SM, SW-SM, SM-SC	A-2, A-3	0	100	95-100	50-80	5-35	<20	NP-5
	23-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	55-80	25-40	5-15

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
52----------------- Wyrene	0-10	Sandy loam--------	SM-SC, ML, SM, SC	A-2, A-4	0	95-100	85-100	60-90	30-65	10-30	NP-10
	10-49	Sandy loam, sand, gravelly sand.	SM, SP-SM	A-1, A-2, A-3	0-5	60-90	55-80	30-70	5-15	<20	NP
	49-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	85-100	75-100	55-90	20-45	5-30
53----------------- Renshaw	0-6	Loam--------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	6-17	Loam, sandy loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	17-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
54B---------------- Arvilla	0-15	Sandy loam--------	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	15-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
56*: Hamerly-----------	0-6	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	6-16	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	16-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
Renshaw-----------	0-6	Loam--------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	6-17	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	17-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
57C---------------- Sioux	0-9	Loam--------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	9-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
58----------------- Divide	0-11	Loam--------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	11-28	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	95-100	85-95	55-80	25-40	5-20
	28-46	Stratified sand to very gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
	46-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	25-40	5-20
65----------------- Ojata	0-9	Clay loam---------	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	80-95	20-50	5-25
	9-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	95-100	85-95	20-50	5-25

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
70---------------- Lallie	0-5	Clay loam--------	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-90	20-45	3-25
	5-60	Silty clay, clay	CL, CH	A-7	0	100	95-100	90-100	85-100	40-95	20-60
75---------------- Lallie	0-5	Clay loam--------	CL	A-6, A-7	0	100	100	85-100	60-95	25-50	10-25
	5-60	Silty clay loam, silty clay, clay.	CL, CH	A-7	0	100	95-100	90-100	85-100	45-95	20-60
77---------------- Minnewaukan	0-4	Loamy fine sand	SM	A-2	0	90-100	70-100	50-85	15-30	---	NP
	4-60	Loamy coarse sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	90-100	70-100	50-100	5-35	---	NP
78C--------------- Wamduska	0-3	Loamy sand-------	SP-SM, SM, SM-SC	A-1, A-2-4, A-3	0-5	95-100	90-100	30-75	5-15	<20	NP-7
	3-6	Gravelly loamy coarse sand, very gravelly sand.	GM, SM	A-1, A-2, A-4	0	60-90	50-80	45-70	25-50	20-35	NP-7
	6-60	Stratified very gravelly sand to very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
81B--------------- Mauvais	0-2	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	70-80	20-40	5-20
	2-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
83B*: Great Bend-------	0-6	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	6-16	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	16-46	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	46-60	Stratified silt loam to silty clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
Overly-----------	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	10-23	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	23-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
84---------------- Bottineau	0-4	Loam-------------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-75	25-45	15-25
	4-50	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
	50-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
84B--------------- Bottineau	0-9	Loam-------------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-75	25-45	15-25
	9-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
1---------------- Tonka	0-9	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
	9-35	0.06-0.2	0.14-0.19	5.6-7.8	<2	High------	0.43		
	35-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
2---------------- Parnell	0-11	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	11-32	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	32-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
4---------------- Southam	0-16	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4
	16-40	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	40-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
5---------------- Grano	0-14	0.06-0.2	0.15-0.18	7.4-8.4	<2	High------	0.28	5	4
	14-60	0.06-0.2	0.14-0.17	7.4-8.4	<2	High------	0.28		
7---------------- Fargo	0-7	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	7-19	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	19-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
8---------------- Colvin	0-12	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	12-28	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	28-60	0.06-2.0	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
11*:									
Svea------------	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	8-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-13	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	13-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
12B*:									
Barnes----------	0-9	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	9-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Svea------------	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	8-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
13C*:									
Barnes----------	0-8	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	8-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
13D*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
13D*:									
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
14C*:									
Svea------------	0-10	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	10-31	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	31-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Sioux-----------	0-9	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	9-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
15C*:									
Esmond----------	0-8	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L
	8-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low--------	0.37		
Emrick----------	0-12	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	12-28	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low--------	0.28		
	28-50	0.6-2.0	0.11-0.21	7.4-8.4	<2	Low--------	0.37		
	50-60	2.0-20	0.06-0.13	7.4-8.4	<2	Low--------	0.17		
16E*:									
Langhei---------	0-4	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	4-60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	7-11	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	11-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
17D*:									
Sioux-----------	0-7	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	7-10	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	10-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
19B*:									
Svea------------	0-9	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	9-26	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
20*, 20B*:									
Hamerly---------	0-7	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-28	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	28-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	8-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
21*:									
Vallers---------	0-8	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low--------	0.28	5	4L
	8-20	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low--------	0.28		
	20-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low--------	0.28		
Hamerly---------	0-15	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	15-28	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	28-60	0.2-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
22----------------- Vallers	0-8	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
	8-20	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	20-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
23*:									
Hamerly-----------	0-6	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	6-28	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	28-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cresbard----------	0-7	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	7-24	0.06-0.6	0.11-0.14	5.6-9.0	2-4	High-------	0.32		
	24-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
24*:									
Svea--------------	0-8	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	8-18	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	18-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cresbard----------	0-7	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	7-24	0.06-0.6	0.11-0.14	5.6-9.0	2-4	High-------	0.32		
	24-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
24B*:									
Barnes------------	0-9	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	9-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cresbard----------	0-6	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	6-18	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	18-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
26*:									
Vallers-----------	0-22	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
	22-31	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	31-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
Parnell-----------	0-11	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
	11-32	0.06-0.2	0.13-0.19	6.6-7.8	<2	High-------	0.28		
	32-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
Tonka-------------	0-9	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	9-35	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	35-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
28C*:									
Zell--------------	0-6	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	6-16	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
	16-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
Maddock-----------	0-7	6.0-20	0.13-0.18	6.6-7.8	<2	Low--------	0.17	5	3
	7-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
30----------------- Embden	0-19	2.0-6.0	0.20-0.22	6.6-7.3	<2	Low--------	0.20	5	5
	19-35	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low--------	0.20		
	35-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low--------	0.20		
31----------------- Svea	0-9	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	9-20	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	20-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
32--------------- Glyndon	0-8	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	4	4L
	8-30	0.6-6.0	0.17-0.20	7.9-9.0	<4	Low-------	0.28		
	30-54	0.6-6.0	0.15-0.22	7.4-8.4	<4	Low-------	0.28		
	54-60	0.6-2.0	0.16-0.22	7.4-8.4	<4	Low-------	0.28		
34--------------- Aberdeen	0-7	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	6
	7-21	0.06-0.2	0.13-0.18	6.6-8.4	<4	High------	0.32		
	21-40	0.06-0.2	0.14-0.17	7.9-9.0	2-8	High------	0.43		
	40-60	0.2-2.0	0.14-0.17	7.9-9.0	2-8	Low-------	0.43		
35--------------- Overly	0-9	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	9-24	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	24-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
36--------------- Bearden	0-9	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	9-18	0.2-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.28		
	18-40	0.06-2.0	0.16-0.22	7.4-8.4	<4	Moderate	0.43		
	40-60	0.06-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
38--------------- Colvin	0-11	0.2-0.6	0.13-0.16	7.4-9.0	4-16	Moderate	0.32	5	4L
	11-60	0.06-2.0	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
39--------------- Colvin	0-11	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	11-38	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	38-60	0.06-2.0	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
40*:									
Colvin----------	0-7	0.2-0.6	0.13-0.16	7.4-9.0	4-16	Moderate	0.32	5	4L
	7-60	0.06-2.0	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
Aberdeen--------	0-6	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	7
	6-22	0.06-0.2	0.13-0.18	6.6-8.4	<4	High------	0.32		
	22-40	0.06-0.2	0.14-0.17	7.9-9.0	2-8	High------	0.43		
	40-60	0.2-2.0	0.14-0.17	7.9-9.0	2-8	Low-------	0.43		
42*:									
Fargo-----------	0-7	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	7-20	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	20-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
Hegne-----------	0-8	0.06-0.2	0.14-0.17	7.4-8.4	<2	High------	0.32	5	4
	8-45	0.06-0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	45-60	0.06-0.2	0.09-0.16	7.4-8.4	<4	High------	0.32		
44--------------- Hegne	0-15	0.06-0.2	0.10-0.15	7.4-9.0	4-16	High------	0.28	5	4
	15-21	0.06-0.2	0.09-0.14	7.4-9.0	4-16	High------	0.28		
	21-60	<0.06	0.07-0.12	7.4-9.0	4-16	High------	0.28		
45--------------- Hegne	0-8	0.06-0.2	0.14-0.17	7.4-8.4	<2	High------	0.32	5	4
	8-45	0.06-0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	45-60	0.06-0.2	0.09-0.16	7.4-8.4	<4	High------	0.32		
46*:									
Aberdeen--------	0-6	0.2-0.6	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	7
	6-22	0.06-0.2	0.13-0.18	6.6-8.4	<4	High------	0.32		
	22-40	0.06-0.2	0.14-0.17	7.9-9.0	2-8	High------	0.43		
	40-60	0.2-2.0	0.14-0.17	7.9-9.0	2-8	Low-------	0.43		
Fargo-----------	0-7	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	7-19	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	19-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
50B---------------	0-7	2.0-6.0	0.13-0.18	6.6-7.8	<2	Low--------	0.20	5	3
Towner	7-23	6.0-20	0.06-0.13	6.6-7.8	<2	Low--------	0.20		
	23-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
52---------------	0-10	2.0-6.0	0.12-0.20	6.6-8.4	<2	Low--------	0.20	3	3
Wyrene	10-49	6.0-20	0.02-0.07	7.4-8.4	<2	Low--------	0.15		
	49-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.28		
53---------------	0-6	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
Renshaw	6-17	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	17-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
54B---------------	0-15	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low--------	0.20	3	3
Arvilla	15-60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
56*:									
Hamerly----------	0-6	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	6-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	16-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Renshaw----------	0-6	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	6-17	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	17-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
57C---------------	0-9	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
Sioux	9-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
58---------------	0-11	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
Divide	11-28	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.28		
	28-46	>6.0	0.03-0.07	7.9-8.4	<2	Low--------	0.10		
	46-60	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low--------	0.32		
65---------------	0-9	0.06-0.6	0.03-0.05	7.4-9.0	>16	Moderate	0.32	5	4L
Ojata	9-60	0.06-0.6	0.07-0.10	7.4-9.0	>8	Moderate	0.43		
70---------------	0-5	0.06-0.2	0.17-0.24	6.6-9.0	<8	Moderate	0.37	5	6
Lallie	5-60	0.06-0.2	0.13-0.23	7.4-9.0	<8	High-------	0.37		
75---------------	0-5	0.06-0.2	0.12-0.19	6.6-9.0	4-16	Moderate	0.37	5	7
Lallie	5-60	0.06-0.2	0.10-0.19	7.4-9.0	4-16	High-------	0.37		
77---------------	0-4	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.15	4	2
Minnewaukan	4-60	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.15		
78C---------------	0-3	6.0-20	0.06-0.10	6.6-7.8	<2	Low--------	0.15	5	2
Wamduska	3-6	6.0-20	0.06-0.10	6.6-8.4	<2	Low--------	0.20		
	6-60	>20	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
81B---------------	0-2	0.6-2.0	0.17-0.19	6.6-8.4	2-8	Low--------	0.32	5	4L
Mauvais	2-60	0.2-0.6	0.12-0.16	7.4-8.4	2-8	Moderate	0.32		
83B*:									
Great Bend-------	0-6	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate	0.32	5	7
	6-16	0.6-2.0	0.17-0.20	6.6-7.8	<2	Moderate	0.43		
	16-46	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low--------	0.43		
	46-60	0.2-0.6	0.17-0.20	7.4-9.0	<4	Low--------	0.43		
Overly-----------	0-10	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	10-23	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	23-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
84---------------- Bottineau	0-4	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.28	5	6
	4-50	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	50-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
84B--------------- Bottineau	0-9	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.28	5	6
	9-30	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "occasional," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1----------------- Tonka	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
2----------------- Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
4----------------- Southam	D	None---------	---	---	+5-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
5----------------- Grano	D	Rare---------	---	---	+1-2.0	Apparent	Apr-Jul	High-----	High-----	Low.
7----------------- Fargo	D	Rare---------	---	---	0-3.0	Apparent	Sep-Jun	High-----	High-----	Low.
8----------------- Colvin	C/D	None---------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
11*:										
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Barnes-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
12B*:										
Barnes-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
13C*, 13D*:										
Barnes-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Buse-------------	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
14C*:										
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Sioux------------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
15C*:										
Esmond-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Emrick-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
16E*:										
Langhei----------	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
Barnes-----------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
17D*:										
Sioux------------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
Buse-------------	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
19B*:										
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Buse-------------	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
20*, 20B*:										
Hamerly----------	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Svea------------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
21*:										
Vallers----------	C	None--------	---	---	0-1.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
Hamerly----------	C	None--------	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
22---------------- Vallers	C	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	High-----	High-----	Low.
23*:										
Hamerly----------	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Cresbard---------	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
24*:										
Svea------------	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Cresbard---------	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
24B*:										
Barnes-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Cresbard---------	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
26*:										
Vallers----------	C	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	High-----	High-----	Low.
Parnell----------	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
Tonka------------	C/D	None--------	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
28C*:										
Zell-------------	B	None--------	---	---	>6.0	---	---	High-----	High-----	Moderate.
Maddock----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
30---------------- Embden	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
31---------------- Svea	B	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
32---------------- Glyndon	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
34---------------- Aberdeen	C	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Moderate.
35---------------- Overly	C	None--------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	High-----	Low.
36---------------- Bearden	C	None--------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
38---------------- Colvin	C	Occasional	Long------	Apr-Jun	0-2.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
39---------------- Colvin	C/D	None--------	---	---	0-1.0	Apparent	Apr-Jul	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
40*:										
Colvin	C	Occasional	Long	Apr-Jun	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
Aberdeen	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
42*:										
Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
Hegne	D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High	Low.
44 Hegne	D	Rare	---	---	+1-2.5	Apparent	Jan-Dec	Moderate	High	Low.
45 Hegne	D	Rare	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High	Low.
46*:										
Aberdeen	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
50B Towner	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
52 Wyrene	B	None	---	---	3.0-5.0	Apparent	Mar-Jun	Moderate	High	Low.
53 Renshaw	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
54B Arvilla	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
56*:										
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Renshaw	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
57C Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
58 Divide	B	None	---	---	2.5-5.0	Apparent	Sep-Jun	Moderate	High	Low.
65 Ojata	D	None	---	---	0-1.0	Apparent	Sep-Jun	High	High	Moderate.
70 Lallie	D	Frequent	Long	Apr-Jun	0-1.0	Apparent	Apr-Aug	High	High	Moderate.
75 Lallie	D	Frequent	Brief	Apr-Jul	+1-1.0	Apparent	Apr-Jun	High	High	Low.
77 Minnewaukan	A/D	None	---	---	0-2.5	Apparent	Apr-Jun	Moderate	High	Low.
78C Wamduska	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
81B Mauvais	C	None	---	---	1.0-4.0	Apparent	Apr-Oct	High	High	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
83B*:										
Great Bend-------	B	None---------	---	---	>6.0	---	---	High-----	High-----	Moderate.
Overly-----------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	High-----	Low.
84, 84B----------- Bottineau	C	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Arvilla sandy loam:														
(S78ND-071-027)														
Bw------ 9 to 15	A-2-6(0)	SM	99	98	95	54	26	---	6	---	36	12	127	10
C2------ 24 to 60	A-1-6(0)	SP	84	69	51	21	3	---	1	---	---	NP	121	12
Bottineau loam:														
(S80ND-071-067)														
BCk2---- 28 to 51	A-7-6(10)	CL	98	96	93	85	66	---	35	---	42	20	109	17
C------- 51 to 60	A-7-6(11)	CL	100	98	94	86	66	---	32	---	41	22	112	15
Lallie clay loam:														
(S80ND-071-066)														
Cy2----- 26 to 42	A-7-5(20)	CH	100	100	100	100	97	---	84	---	94	59	104	19
Cy3----- 42 to 60	A-7-6(20)	CH	100	100	99	99	97	---	82	---	71	45	112	16
Langhei loam:														
(S78ND-071-016)														
BCk----- 15 to 23	A-6(8)	ML	100	98	95	88	72	---	30	---	37	12	110	16
C------- 23 to 60	A-6(8)	CL	100	97	91	83	65	---	28	---	37	16	112	15
Mauvais loam:														
(S81ND-071-077)														
Cy------ 2 to 50	A-6(8)	CL	98	96	92	80	58	---	23	---	39	18	111	16
Renshaw loam:														
(S80ND-071-070)														
Bw2----- 11 to 14	A-6(7)	CL	100	99	96	85	67	---	18	---	33	13	112	16
2C------ 30 to 60	A-1	SW-SM	85	79	68	45	10	---	4	---	---	NP	---	---
Zell loam:														
(S78ND-071-019)														
C1------ 16 to 36	A-4(8)	CL-ML	100	100	100	100	94	---	14	---	29	7	113	15
C2------ 36 to 60	A-4(5)	ML	100	100	99	98	60	---	10	---	---	NP	118	13

TABLE 18.--CLASSIFICATION OF THE SOILS

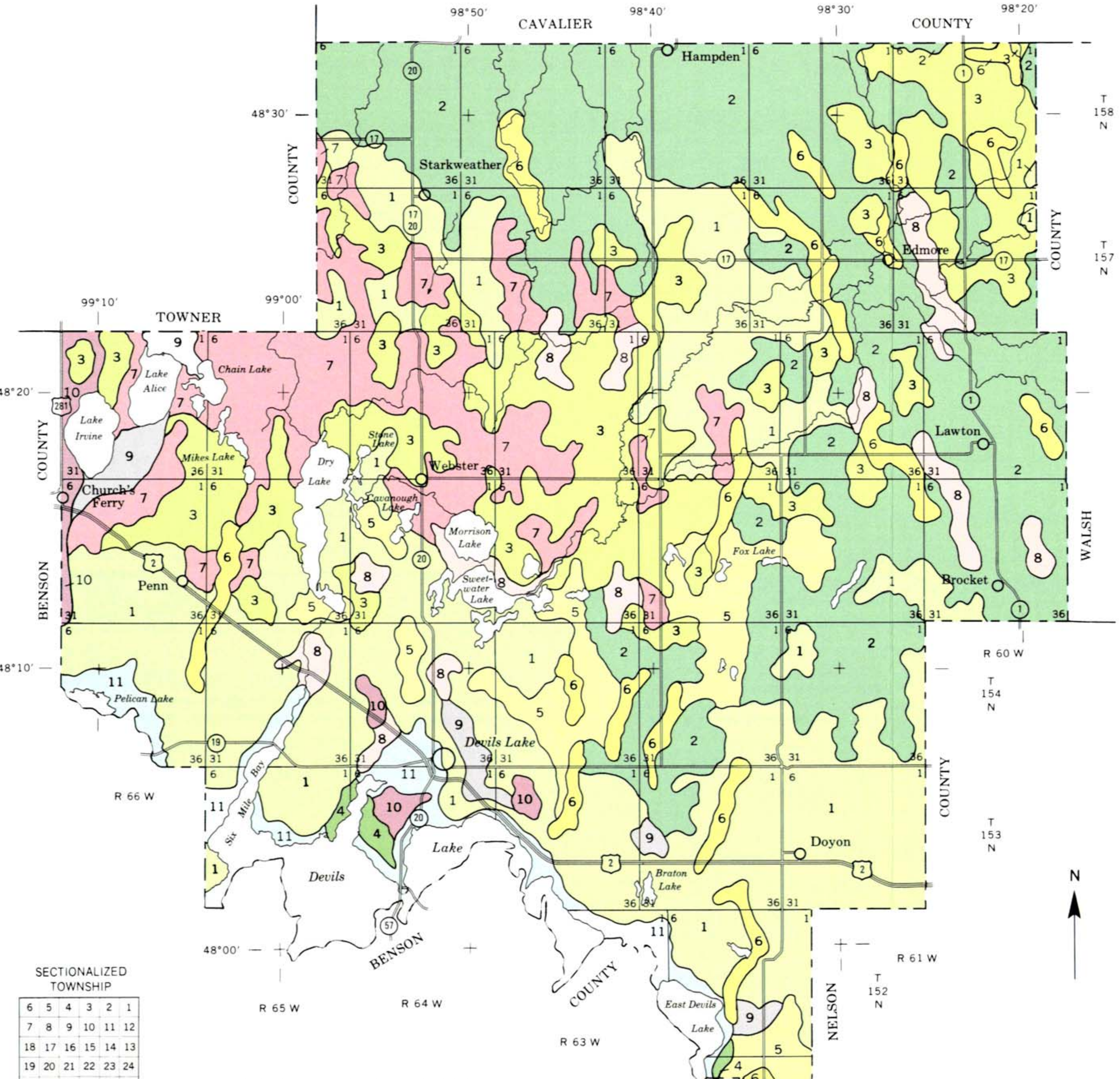
[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Bottineau	Fine-loamy, mixed Udic Argiborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Grano	Fine, montmorillonitic (calcareous), frigid Vertic Haplaquolls
Great Bend	Fine-silty, mixed Udic Haploborolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hegne	Fine, frigid Typic Calciaquolls
Lallie	Fine, montmorillonitic (calcareous), frigid Typic Fluvaquents
Langhei	Fine-loamy, mixed (calcareous), frigid Typic Udorthents
Maddock	Sandy, mixed Udorthentic Haploborolls
Mauvais	Fine-loamy, mixed (calcareous), frigid Aeric Haplaquents
Minnewaukan	Mixed, frigid Typic Psammaquents
*Ojata	Fine-silty, frigid Typic Calciaquolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wamduska	Sandy, mixed, frigid Typic Udorthents
Wyrene	Sandy, frigid Aeric Calciaquolls
Zell	Coarse-silty, mixed Udorthentic Haploborolls

☆ U.S. GOVERNMENT PRINTING OFFICE : 1986 O - 482-140 : QL 3

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND *

DOMINANTLY LEVEL TO GENTLY ROLLING, MEDIUM TEXTURED SOILS

1 Svea-Hamerly-Barnes association: Deep, level to gently rolling, well drained to somewhat poorly drained soils

2 Svea-Vallers-Buse association: Deep, level to gently rolling, well drained, moderately well drained, and poorly drained soils

3 Hamerly-Cresbard-Svea association: Deep, level to undulating, moderately well drained and somewhat poorly drained soils

4 Bottineau association: Deep, nearly level and undulating, well drained soils

DOMINANTLY NEARLY LEVEL TO HILLY, MEDIUM TEXTURED SOILS

5 Barnes-Buse-Svea association: Deep, undulating to hilly, well drained and moderately well drained soils

6 Svea-Sioux-Buse association: Deep, nearly level to rolling, excessively drained, well drained, and moderately well drained soils

DOMINANTLY LEVEL TO GENTLY SLOPING, MEDIUM TEXTURED, MODERATELY FINE TEXTURED, AND FINE TEXTURED SOILS

7 Hamerly-Hegne-Fargo association: Deep, level and nearly level, somewhat poorly drained and poorly drained soils

8 Colvin-Vallers-Aberdeen association: Deep, level and nearly level, moderately well drained and poorly drained soils

9 Hegne-Grano-Aberdeen association: Deep, level, moderately well drained, poorly drained, and very poorly drained soils

10 Bearden-Overly-Embden association: Deep, level to gently sloping, moderately well drained and somewhat poorly drained soils

DOMINANTLY LEVEL TO MODERATELY SLOPING, MODERATELY FINE TEXTURED, MEDIUM TEXTURED, AND COARSE TEXTURED SOILS

11 Lallie-Mauvais-Wamduska association: Deep, level to moderately sloping, excessively drained, somewhat poorly drained, and poorly drained soils

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

Compiled 1984

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS

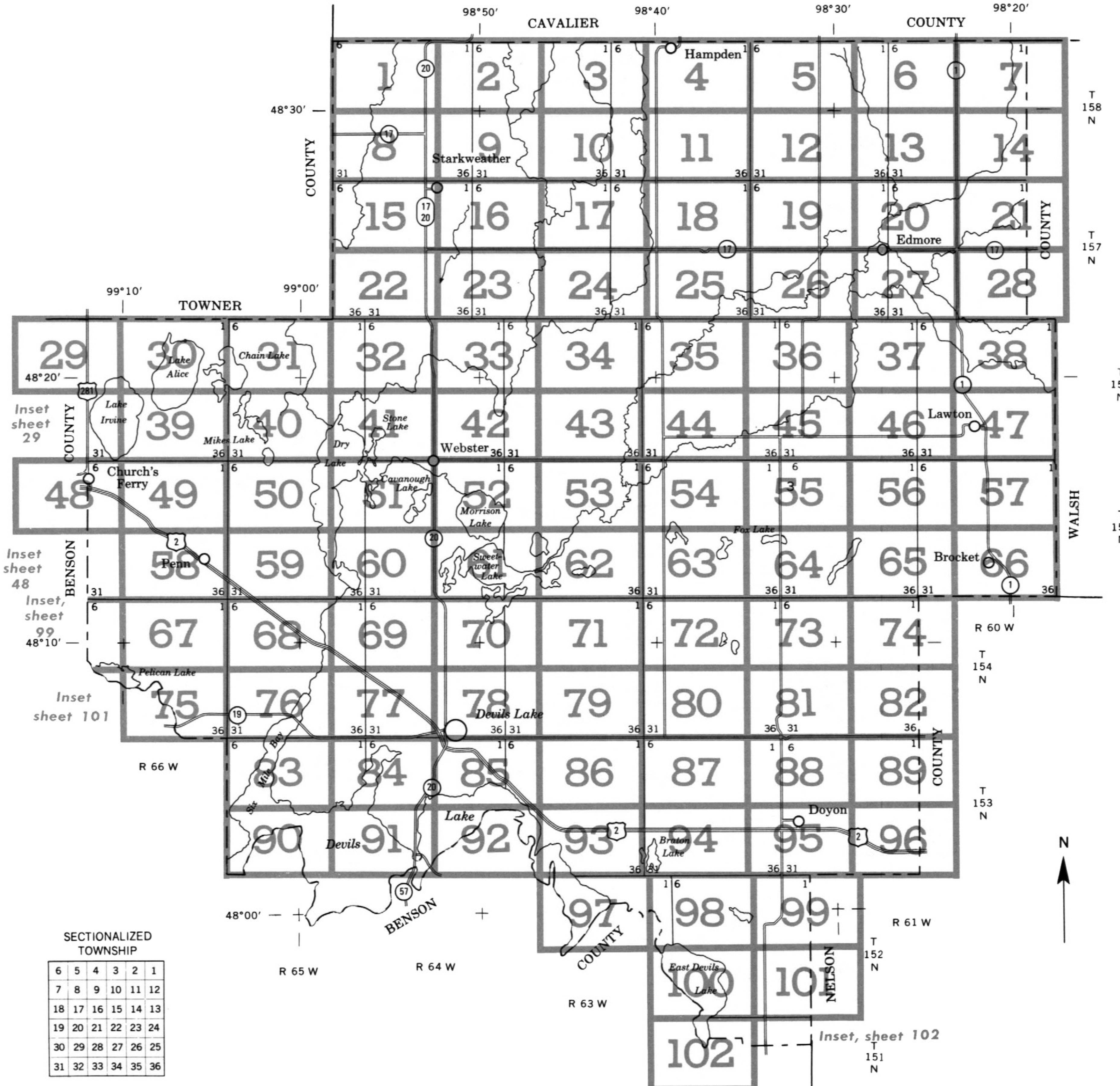
GENERAL SOIL MAP

RAMSEY COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS
RAMSEY COUNTY, NORTH DAKOTA

Scale 1:316,800

1 0 1 2 3 4 5 Miles

1 0 5 10 Km

SOIL LEGEND

Map symbols consist of a number or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
1	Tonka silt loam
2	Parnell silty clay loam
4	Southam silty clay loam
5	Grano silty clay
7	Fargo silty clay
8	Colvin silty clay loam, wet
11	Svea-Barnes loams, 1 to 3 percent slopes
12B	Barnes-Svea loams, 3 to 6 percent slopes
13C	Barnes-Buse loams, 6 to 9 percent slopes
13D	Barnes-Buse loams, 9 to 15 percent slopes
14C	Svea-Sioux loams, 1 to 9 percent slopes
15C	Esmond-Emrick loams, 3 to 9 percent slopes
16E	Langhei-Barnes loams, 9 to 40 percent slopes
17D	Sioux-Buse loams, 9 to 15 percent slopes
19B	Svea-Buse loams, 3 to 6 percent slopes
20	Hamerly-Svea loams, 1 to 3 percent slopes
20B	Hamerly-Svea loams, 3 to 6 percent slopes
21	Vallers-Hamerly loams, saline, 0 to 3 percent slopes
22	Vallers loam
23	Hamerly-Cresbard loams, 1 to 3 percent slopes
24	Svea-Cresbard loams, 1 to 3 percent slopes
24B	Barnes-Cresbard loams, 3 to 6 percent slopes
26	Vallers-Parnell-Tonka complex, 0 to 3 percent slopes
28C	Zell-Maddock complex, 3 to 9 percent slopes
30	Embden loam, 0 to 3 percent slopes
31	Svea loam, 1 to 3 percent slopes
32	Glyndon silt loam, 0 to 3 percent slopes
34	Aberdeen silt loam
35	Overly silty clay loam, 0 to 3 percent slopes
36	Bearden silty clay loam
38	Colvin silty clay loam, saline
39	Colvin silty clay loam
40	Colvin-Aberdeen silty clay loams
42	Fargo-Hegne silty clays
44	Hegne silty clay, saline
45	Hegne silty clay
46	Aberdeen-Fargo silty clay loams
50B	Towner sandy loam, 1 to 6 percent slopes
52	Wyrene sandy loam, loamy substratum, 0 to 3 percent slopes
53	Renshaw loam, 1 to 3 percent slopes
54B	Arvilla sandy loam, 1 to 6 percent slopes
56	Hamerly-Renshaw loams, 0 to 3 percent slopes
57C	Sioux loam, 1 to 9 percent slopes
58	Divide loam, loamy substratum, 1 to 3 percent slopes
65	Ojata clay loam
70	Lallie clay loam
75	Lallie clay loam, saline
77	Minnewaukan loamy fine sand, 1 to 3 percent slopes
78C	Wamduska loamy sand, 1 to 9 percent slopes
81B	Mauvais loam, 0 to 6 percent slopes
83B	Great Bend-Overly silty clay loams, 3 to 6 percent slopes
84	Bottineau loam, 1 to 3 percent slopes
84B	Bottineau loam, 3 to 6 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label) — Hedley Airstrip

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water

PITS — w

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
- Double-line (label) — CANAL
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 23, 83B

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

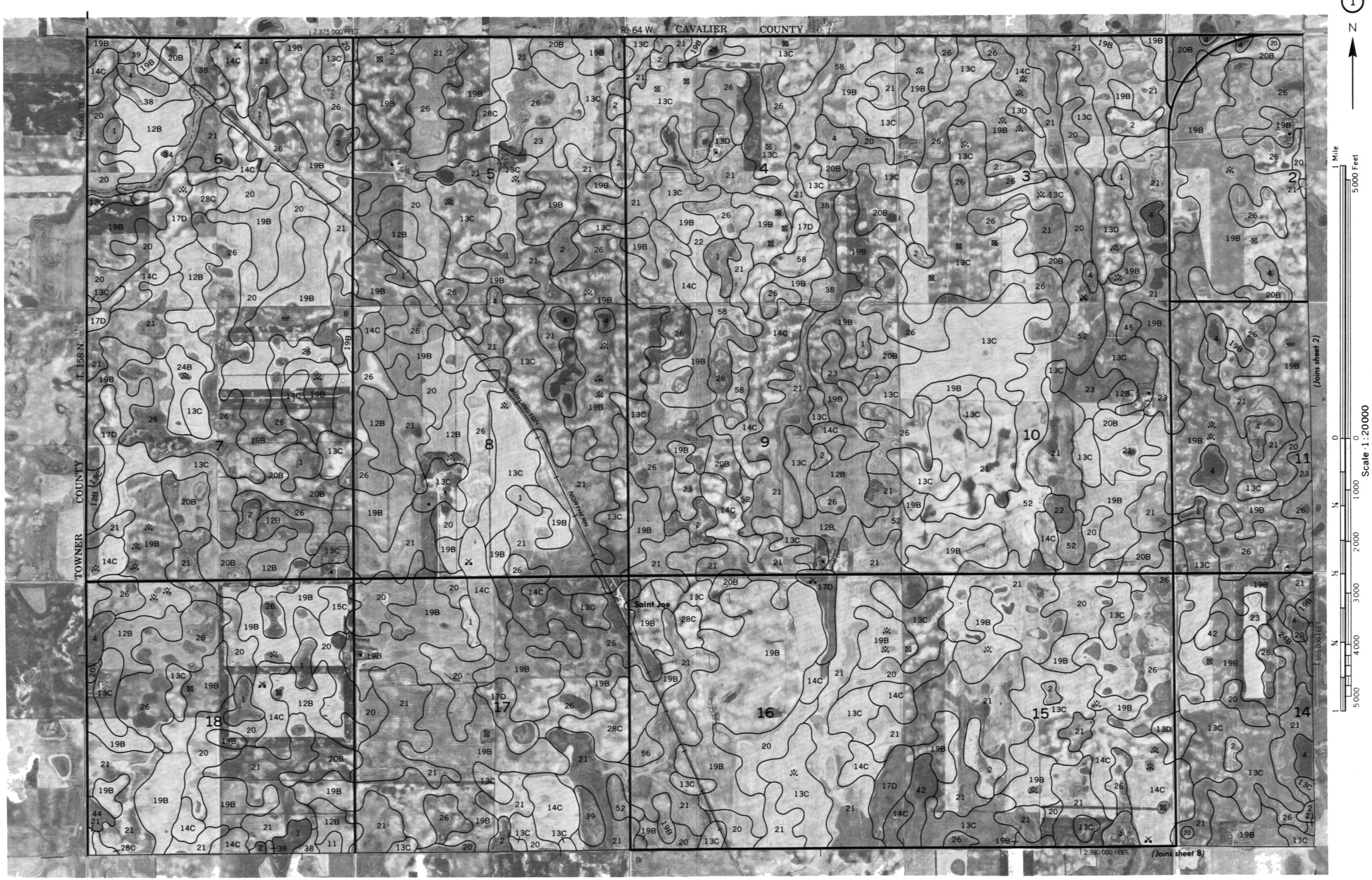
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Parnell soil spot up to 3 acres in size
- Tonka soil spot up to 3 acres in size

RAMSEY COUNTY, NORTH DAKOTA NO. 1

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



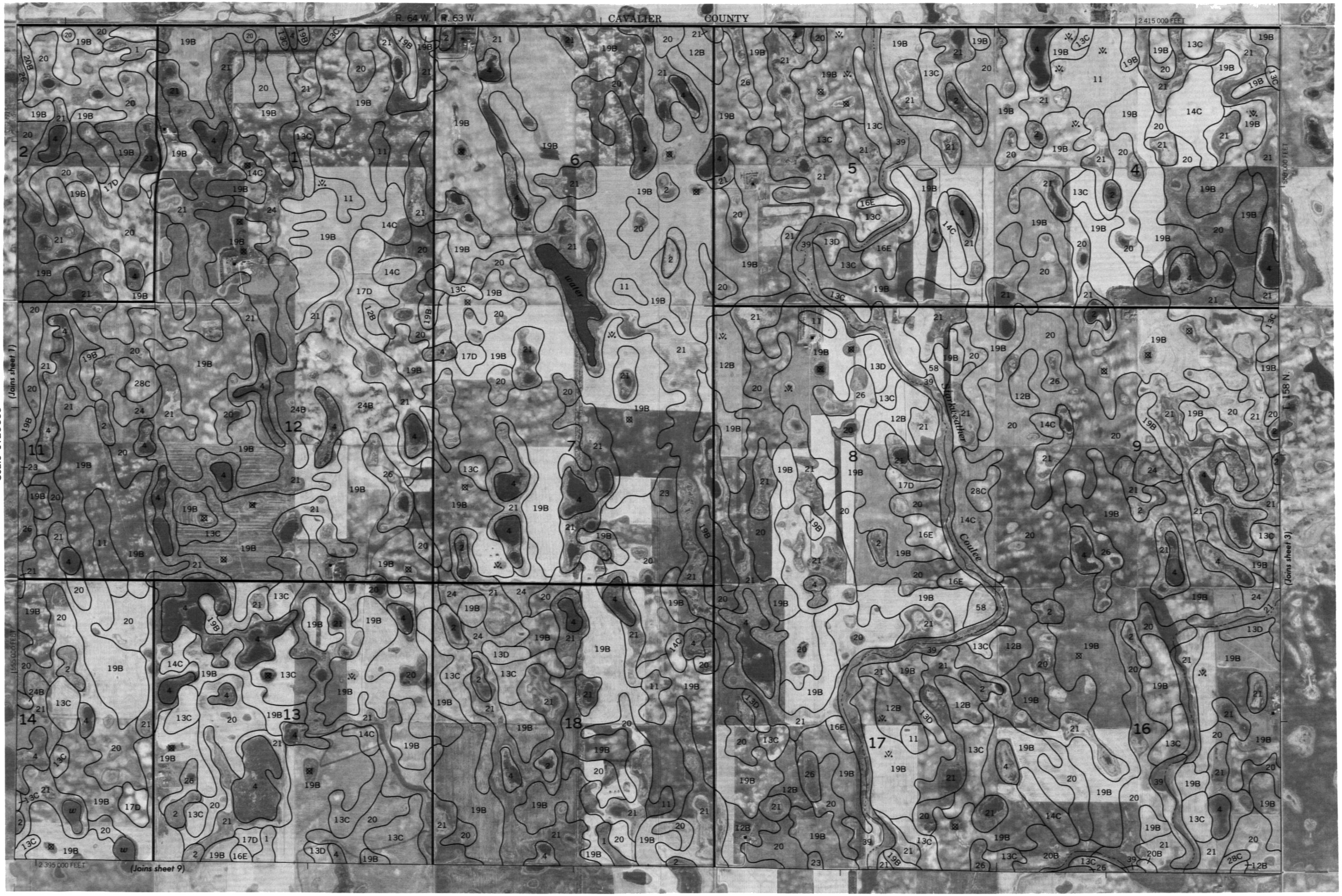
RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 2

N

1 Mile

5000 Feet

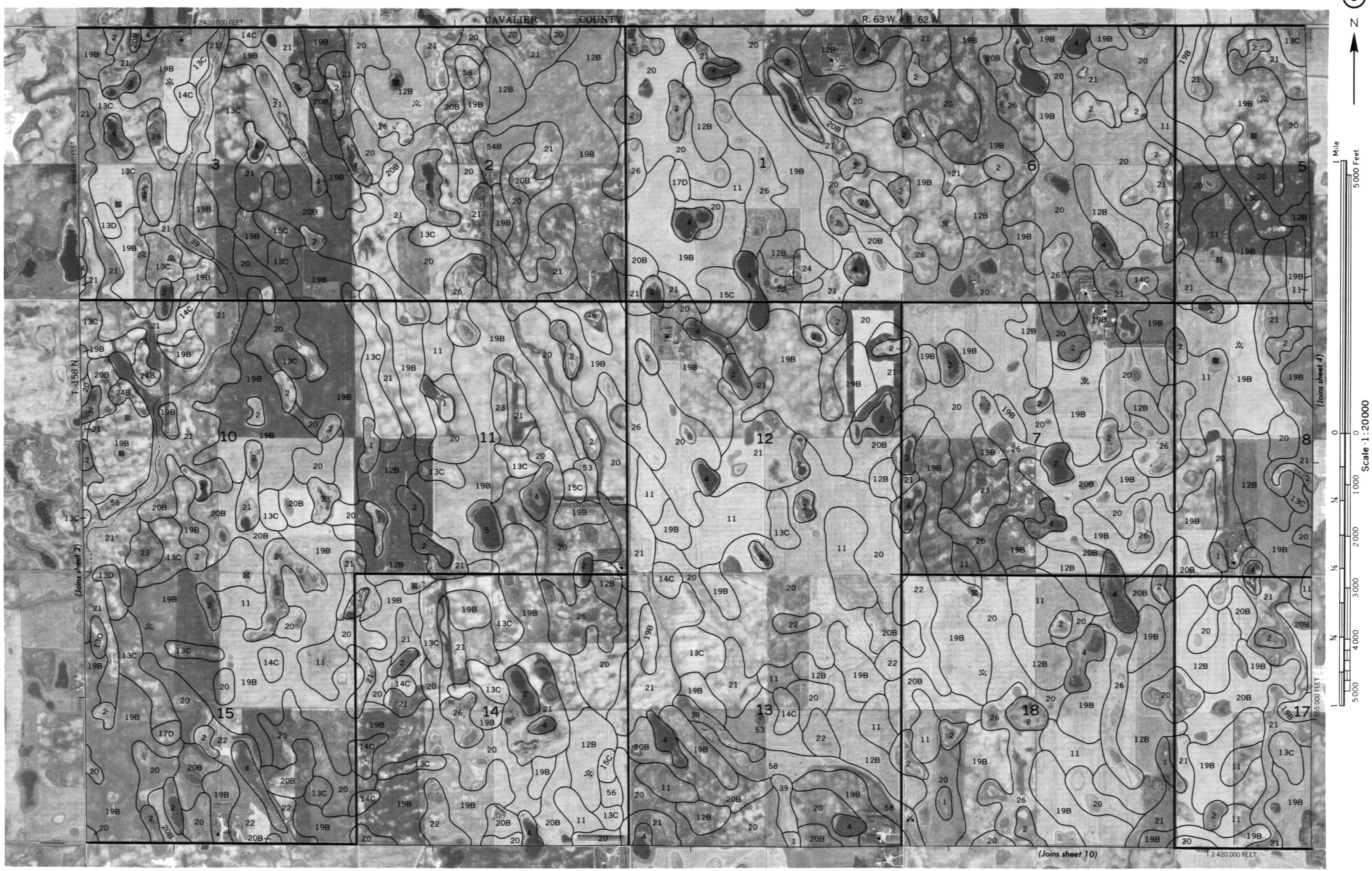
Scale 1:20000



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 2

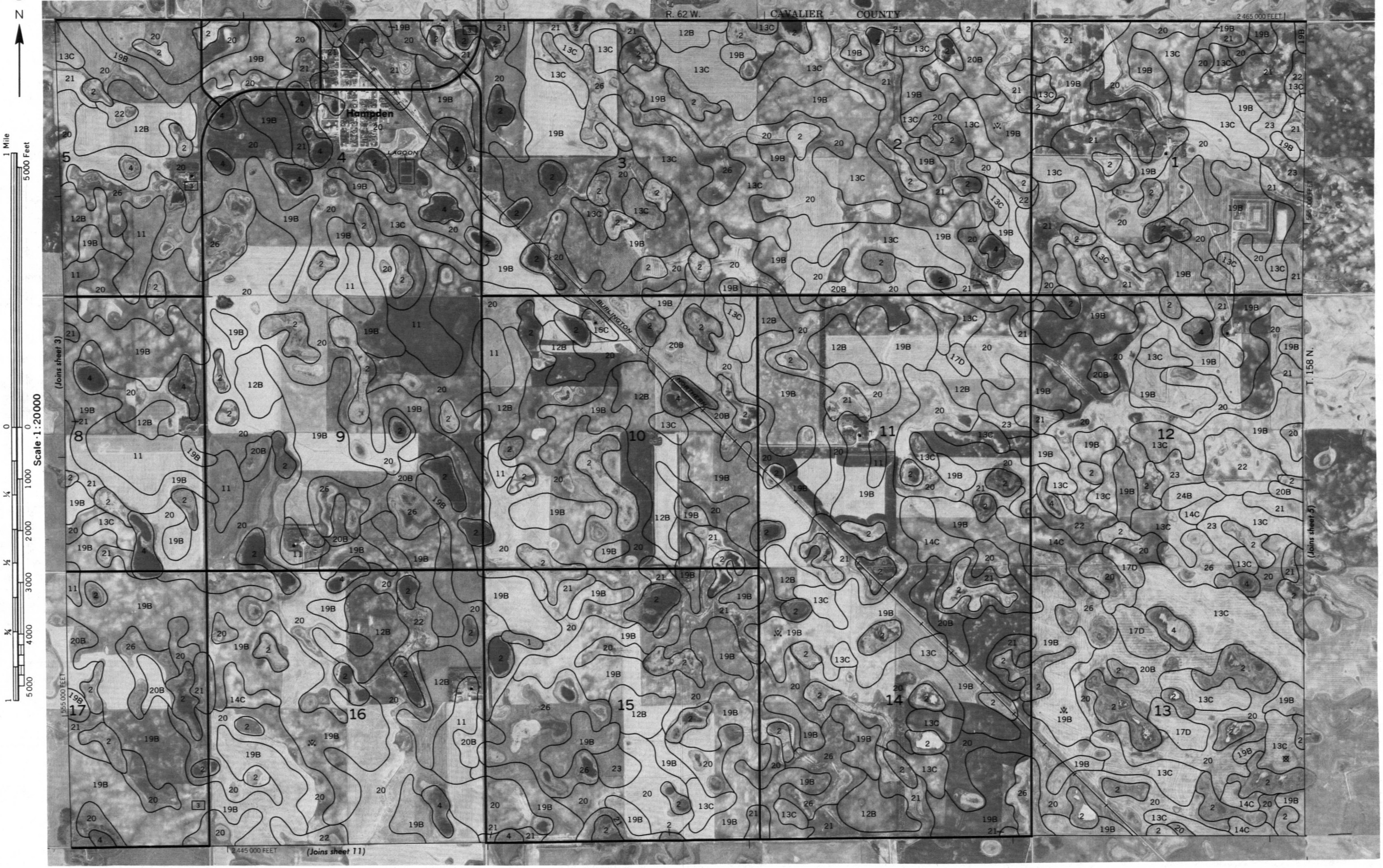
3



RAMSEY COUNTY, NORTH DAKOTA NO. 3

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

4

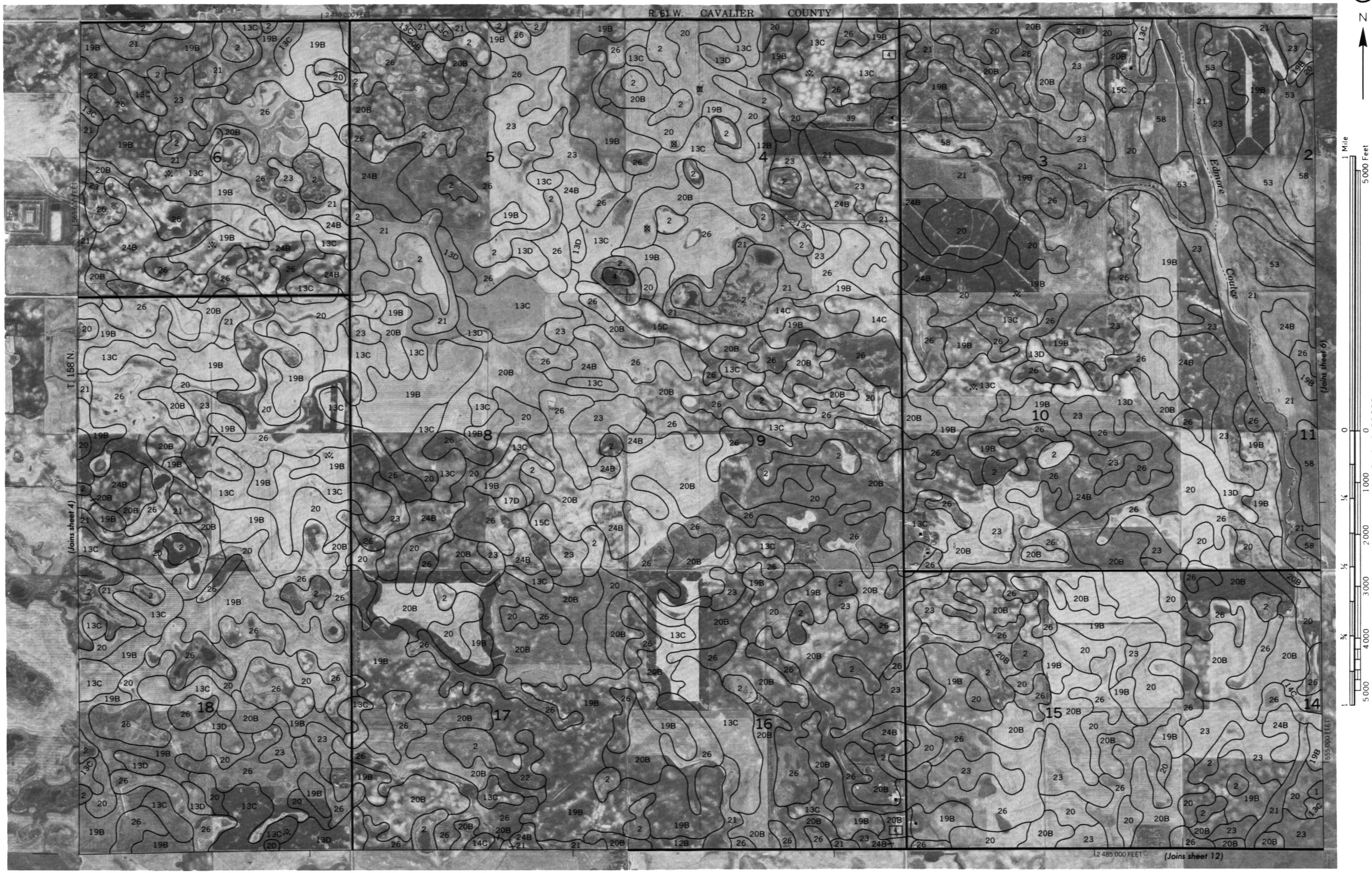


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 4

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 5

5



RAMSEY COUNTY, NORTH DAKOTA NO. 5

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

6

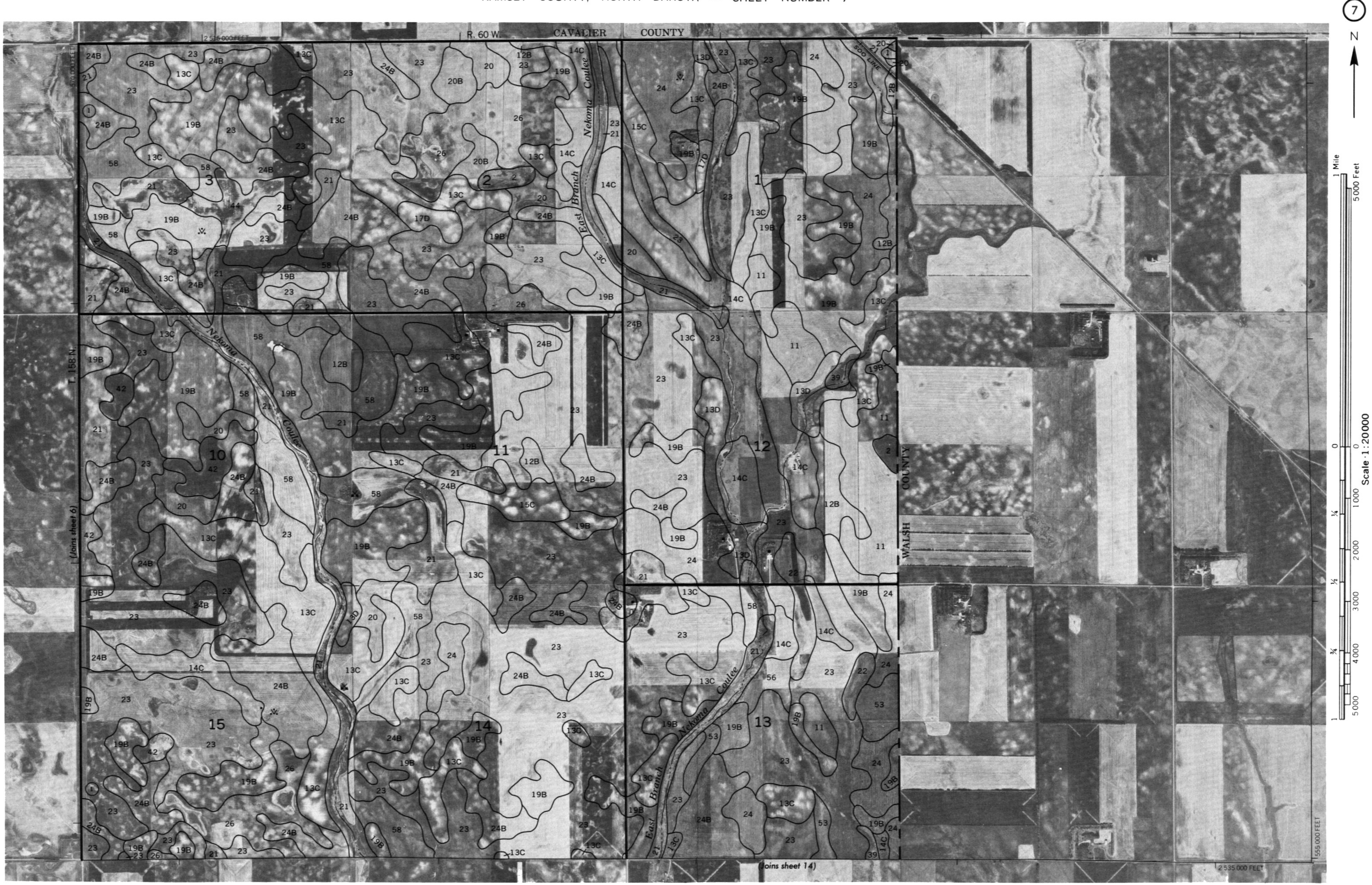
N

1 Mile

5000 Feet

Scale 1:20000

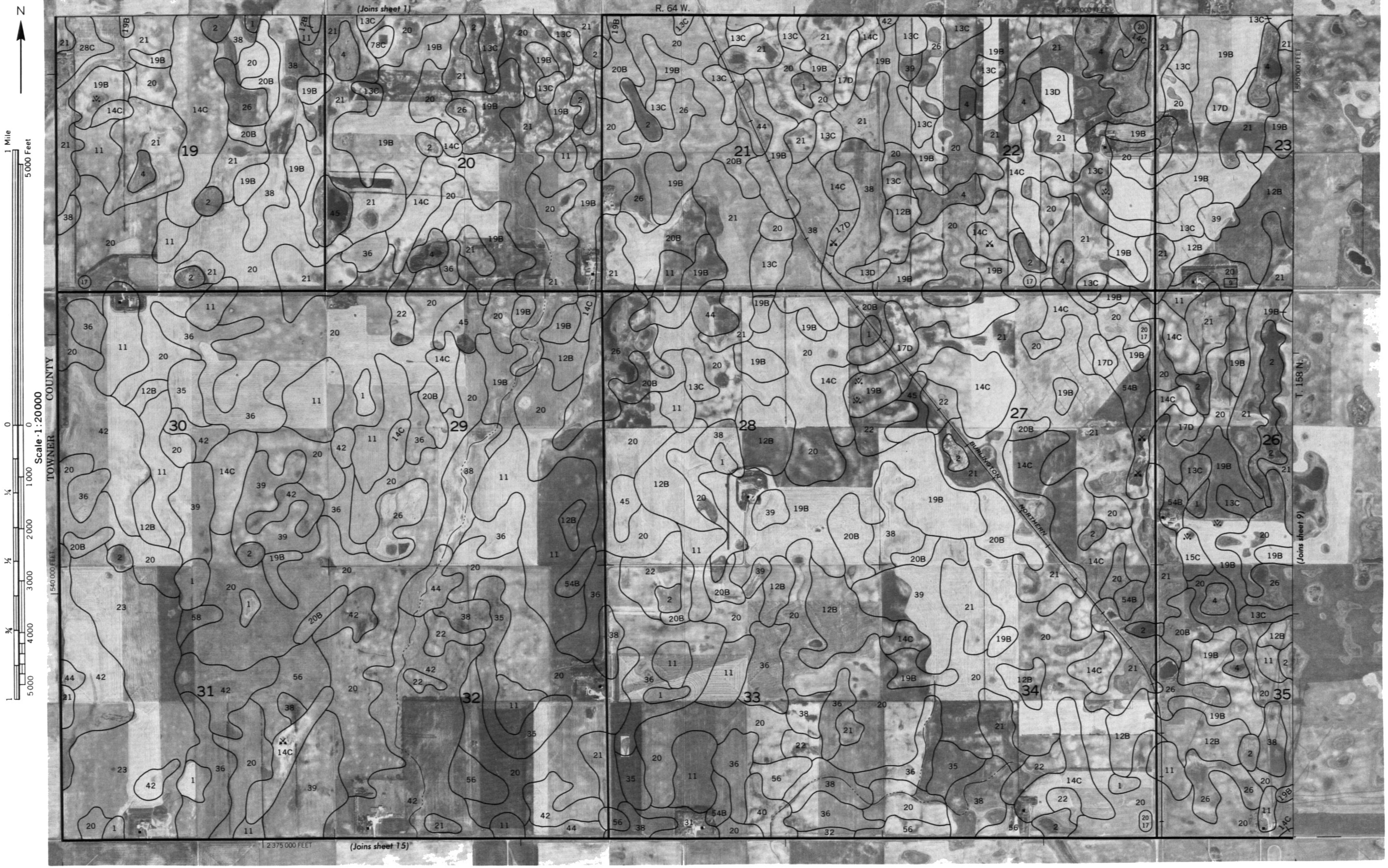
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



RAMSEY COUNTY, NORTH DAKOTA NO. 7

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

8



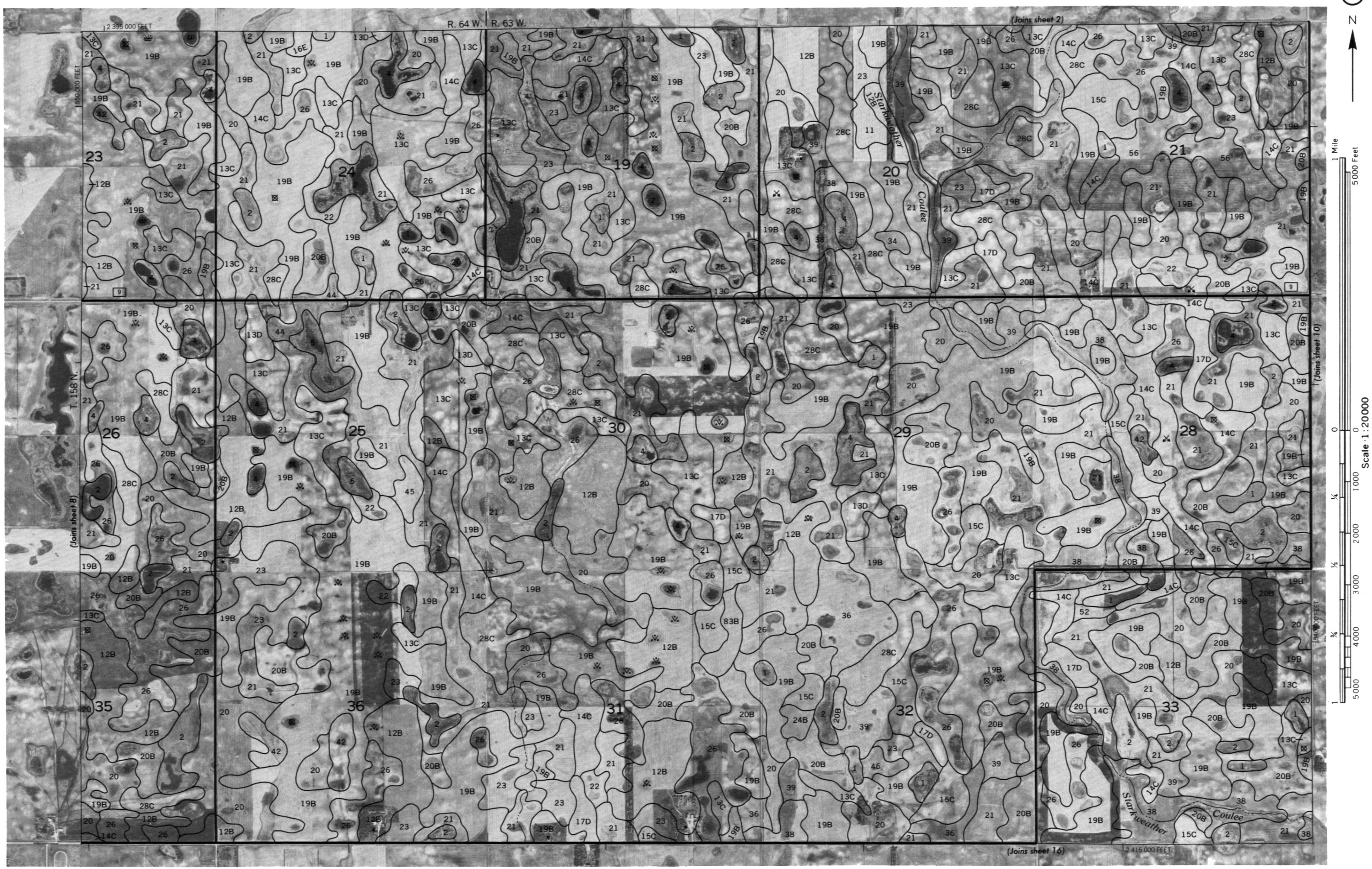
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

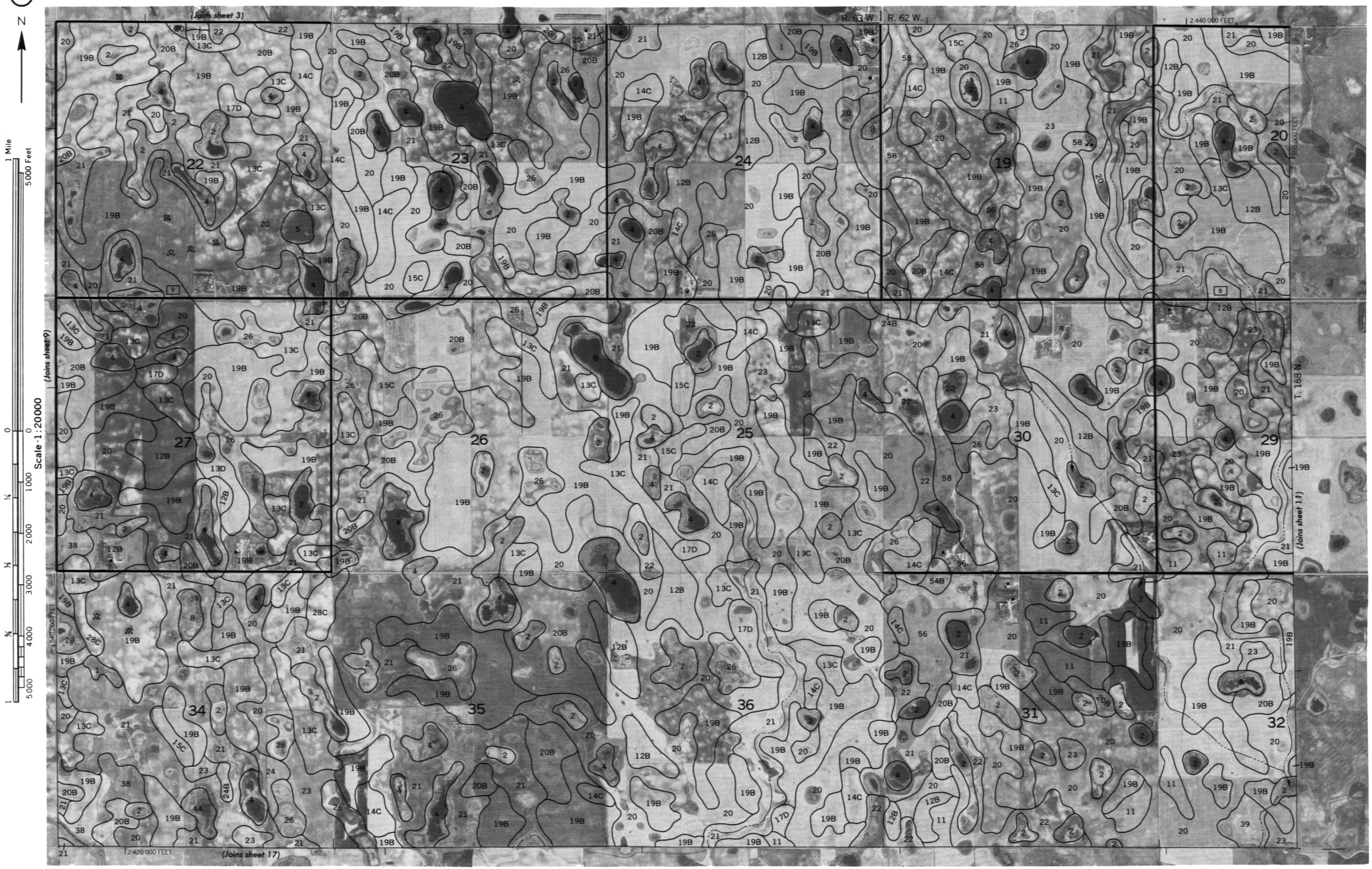
RAMSEY COUNTY, NORTH DAKOTA NO. 8

(9)

RAMSEY COUNTY, NORTH DAKOTA NO. 9

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

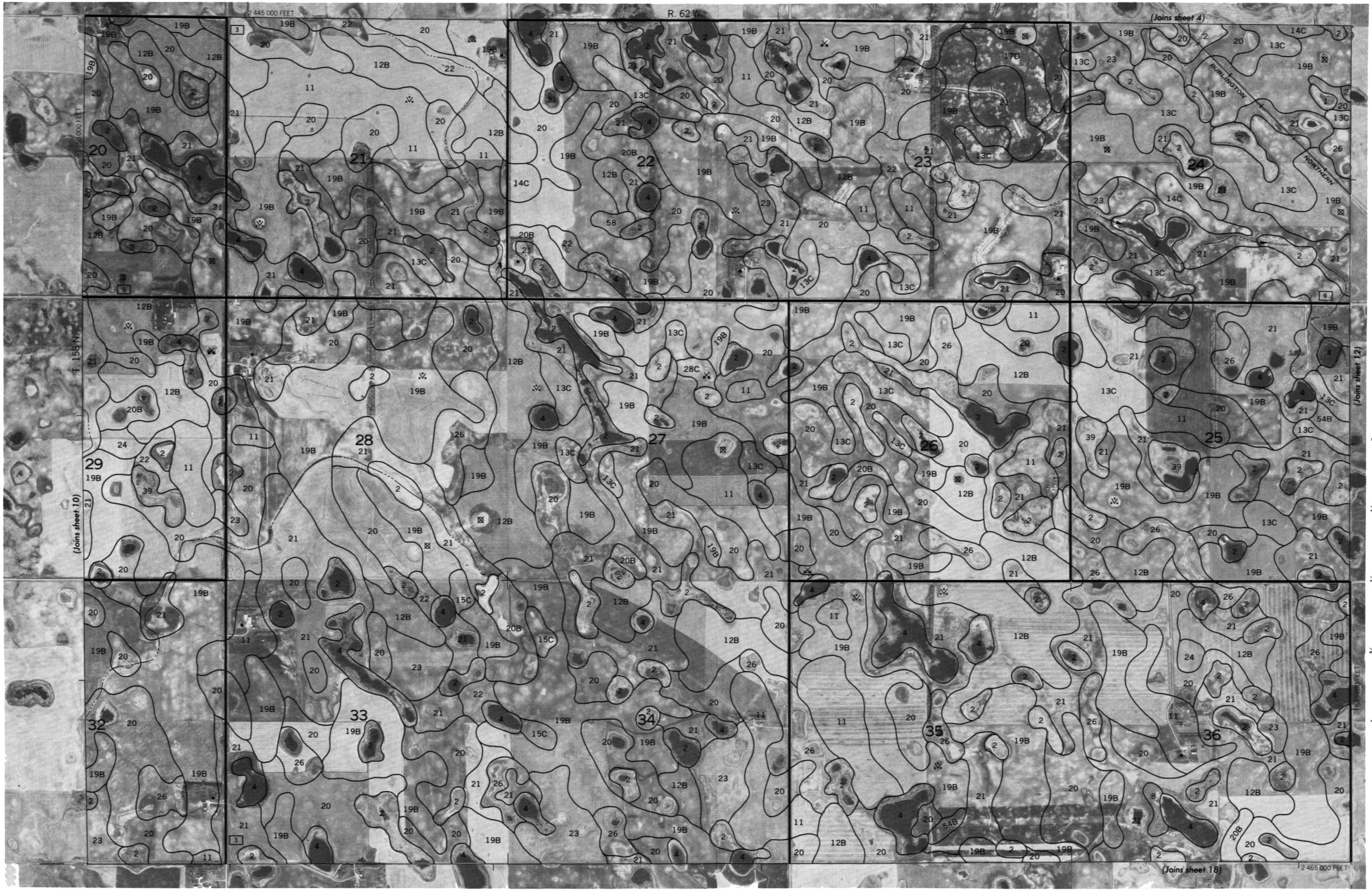




This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

11

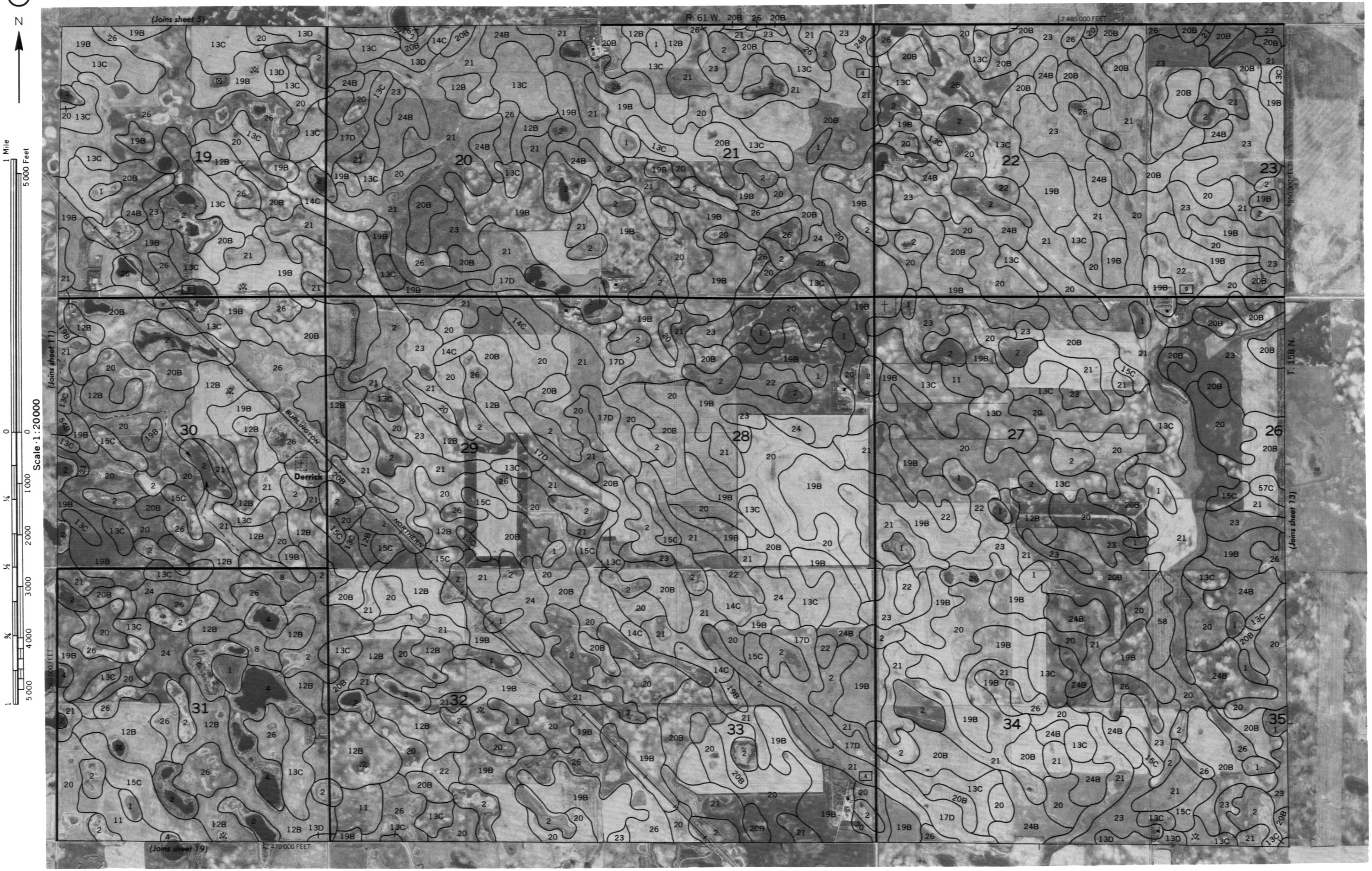
N



1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 11

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



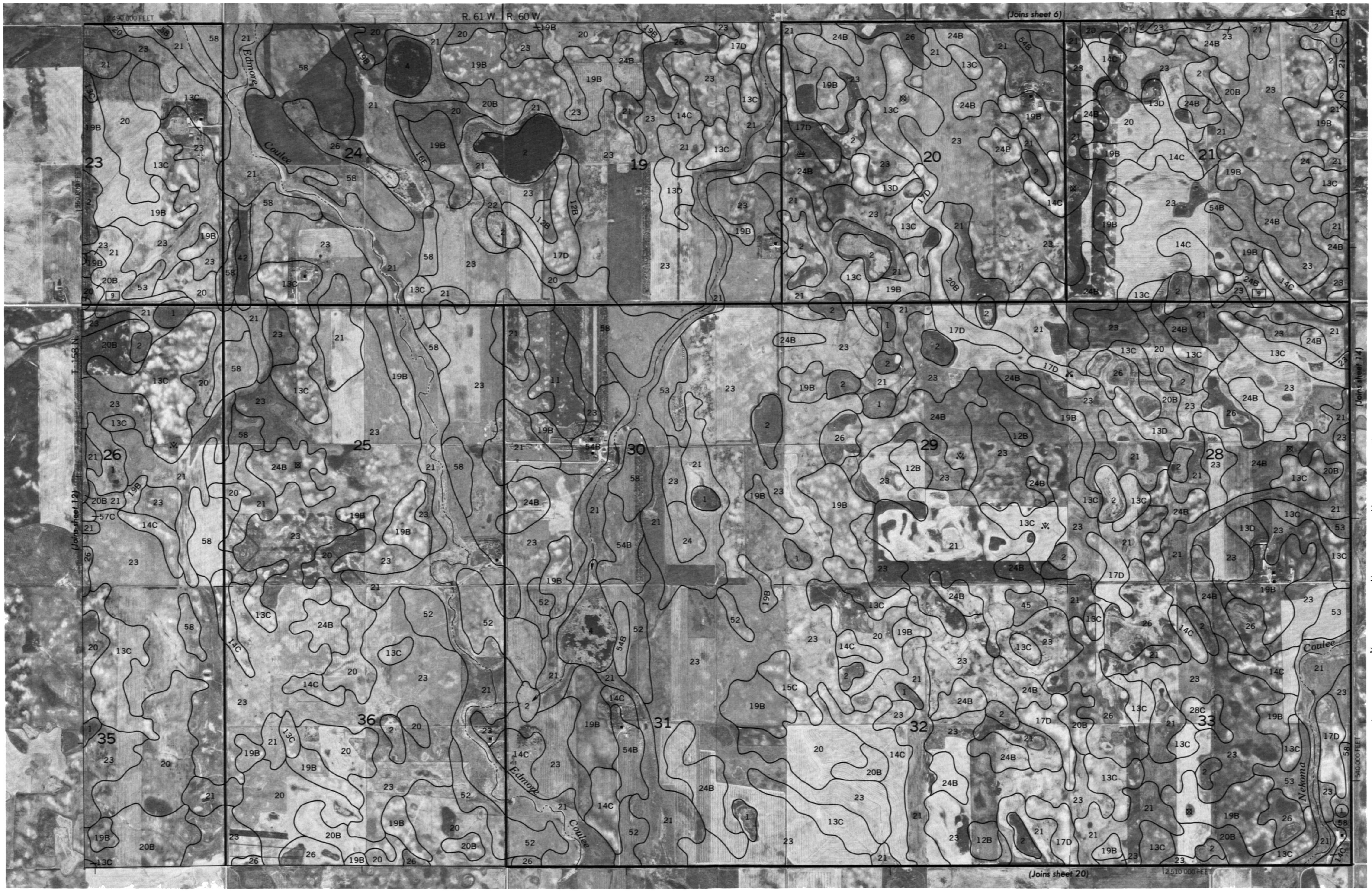
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 12

13

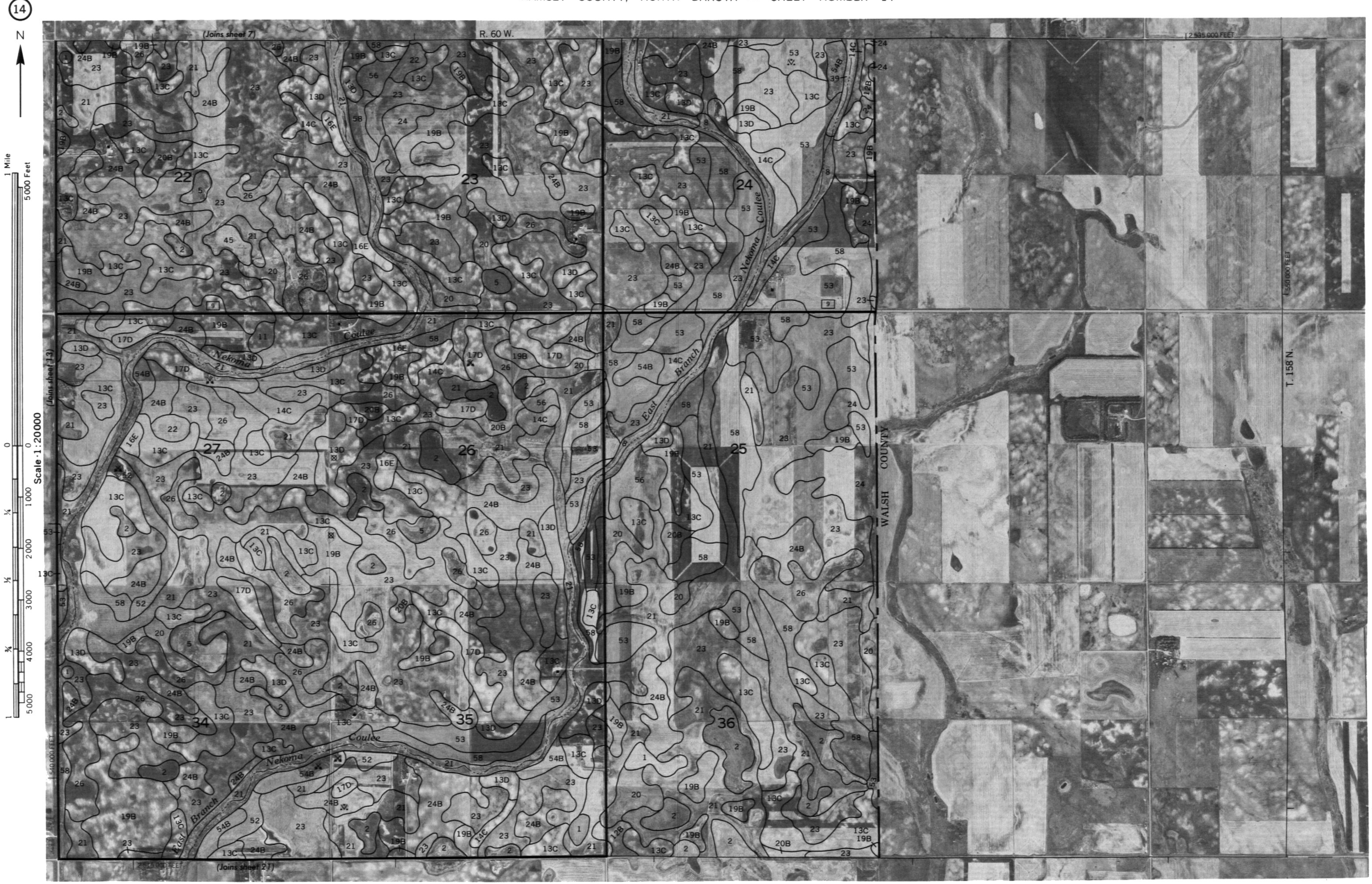
RAMSEY COUNTY, NORTH DAKOTA NO. 13

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



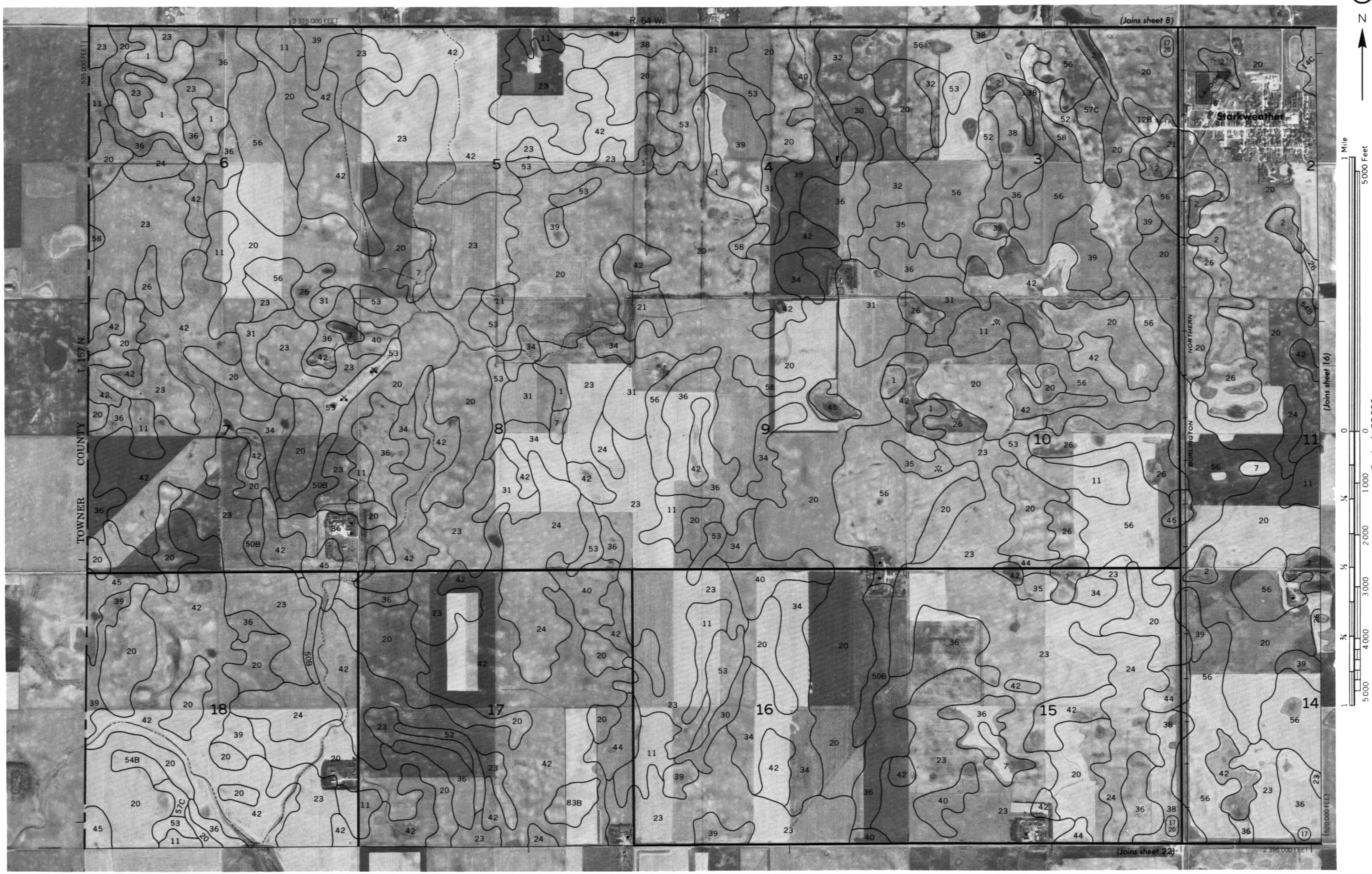
N

1 Mile
5000 Feet
Scale 1:20000



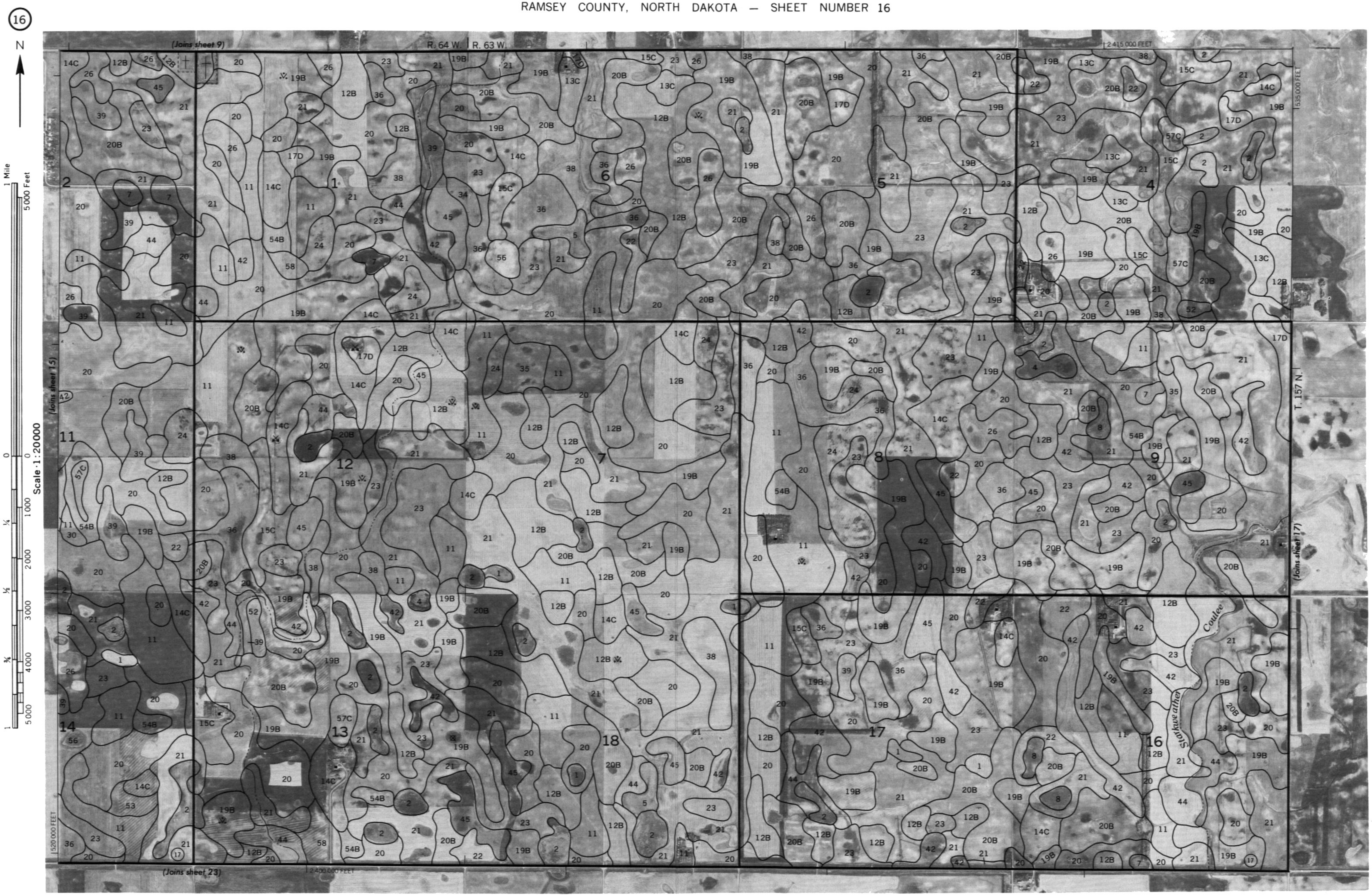
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

15



RAMSEY COUNTY, NORTH DAKOTA NO. 15

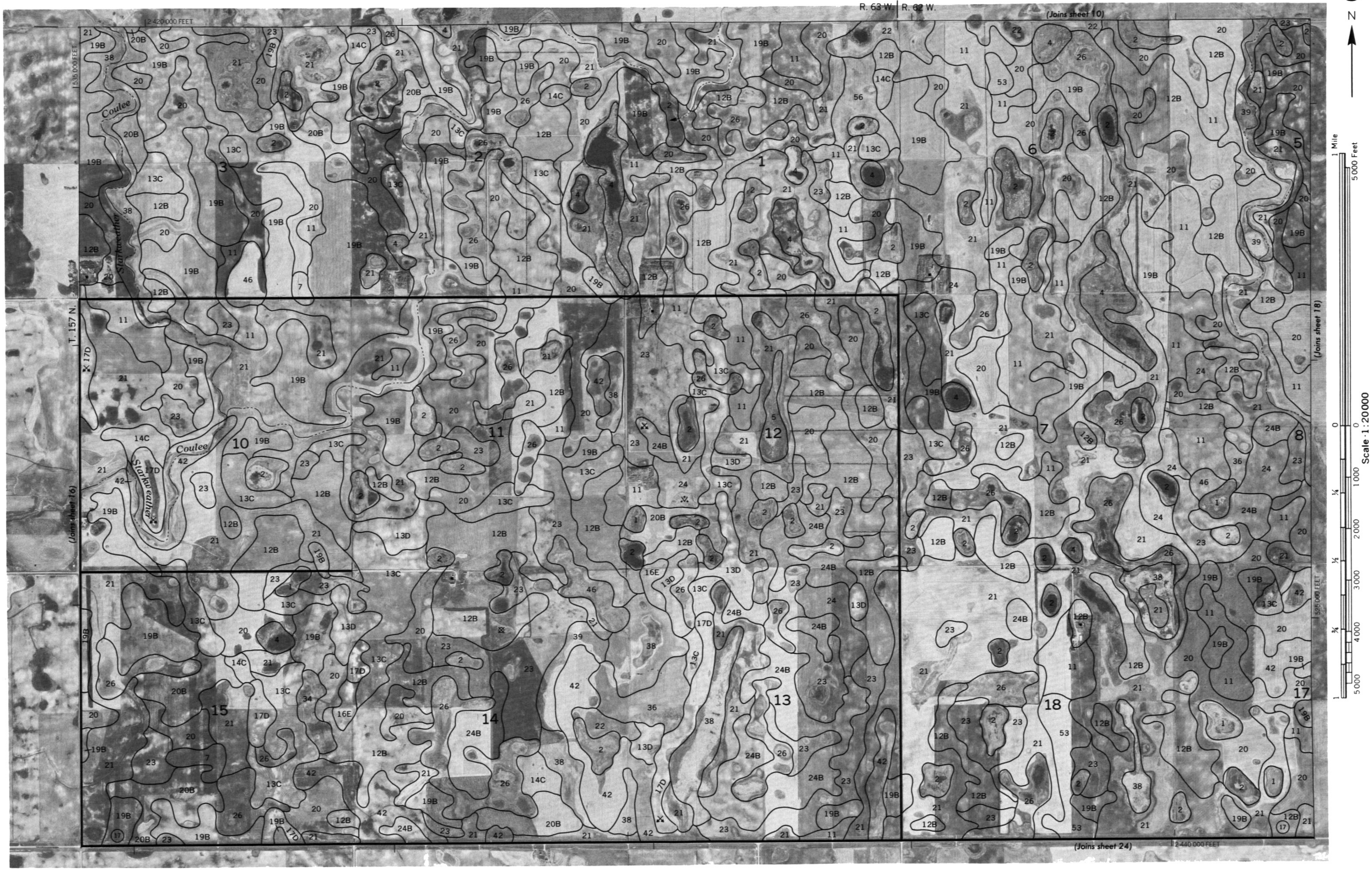
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 16

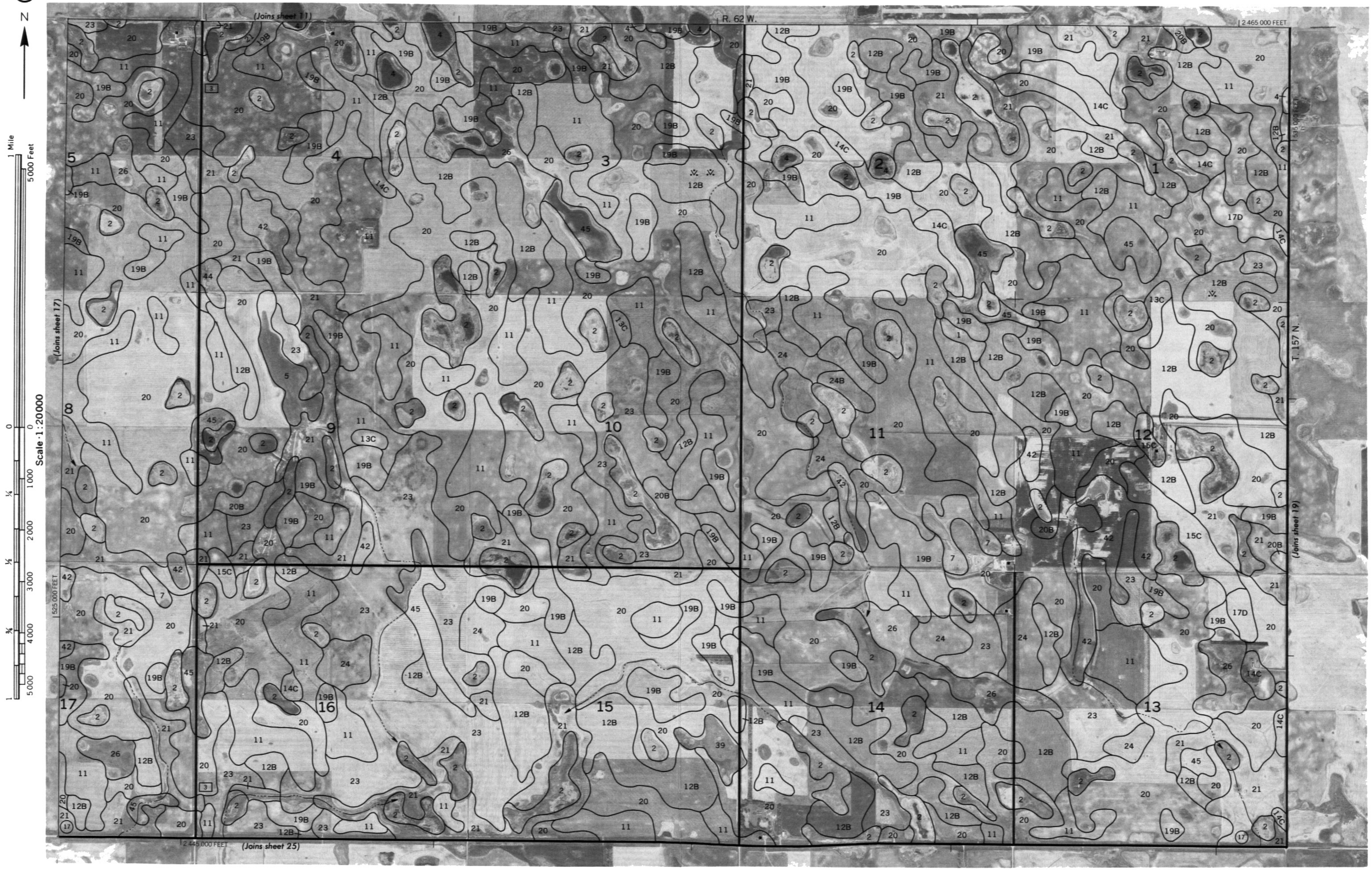
17



RAMSEY COUNTY, NORTH DAKOTA NO. 17

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 18

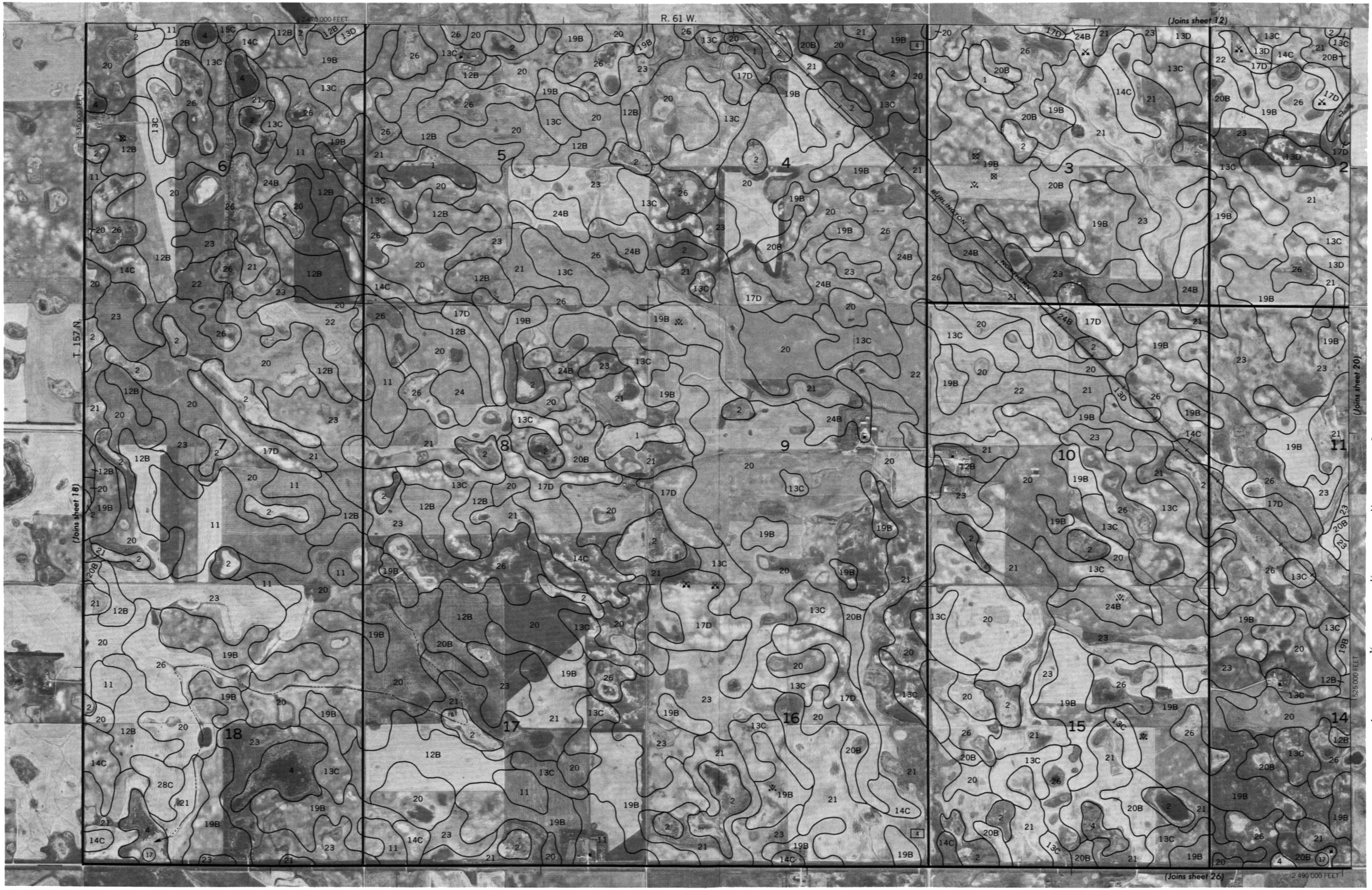


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 18

19

N



1 Mile

5000 Feet

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

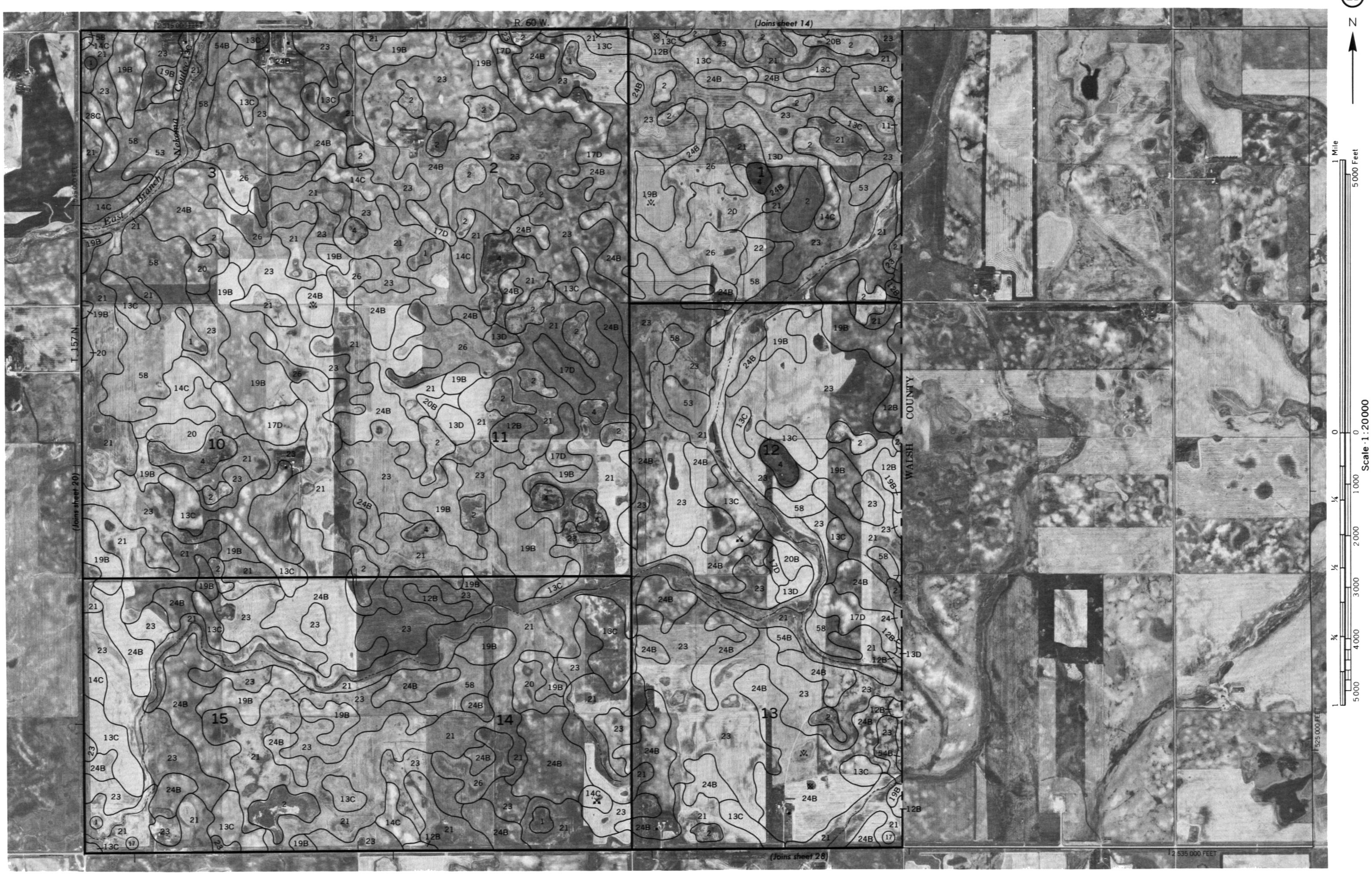
Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 19

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

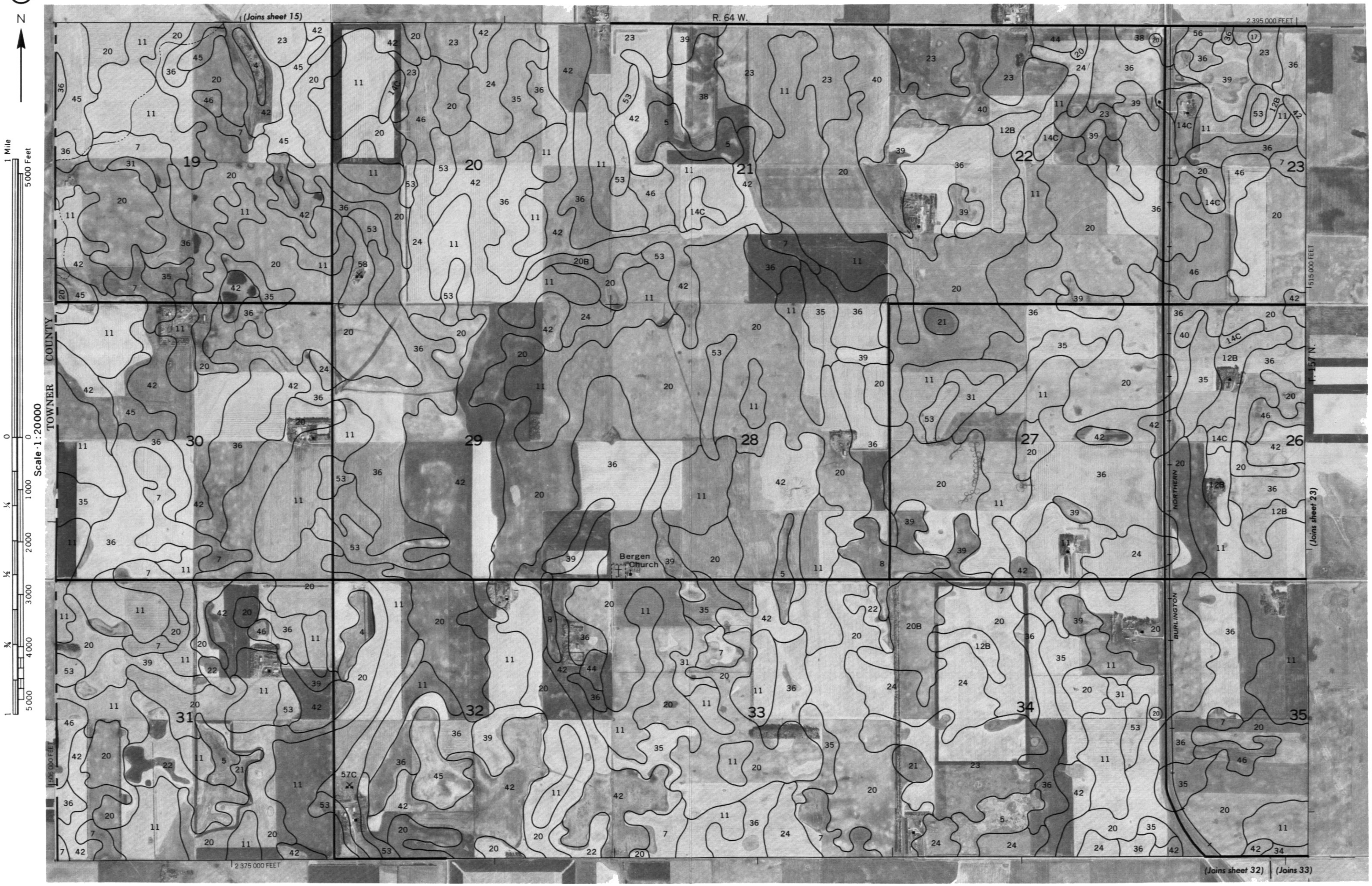
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 20

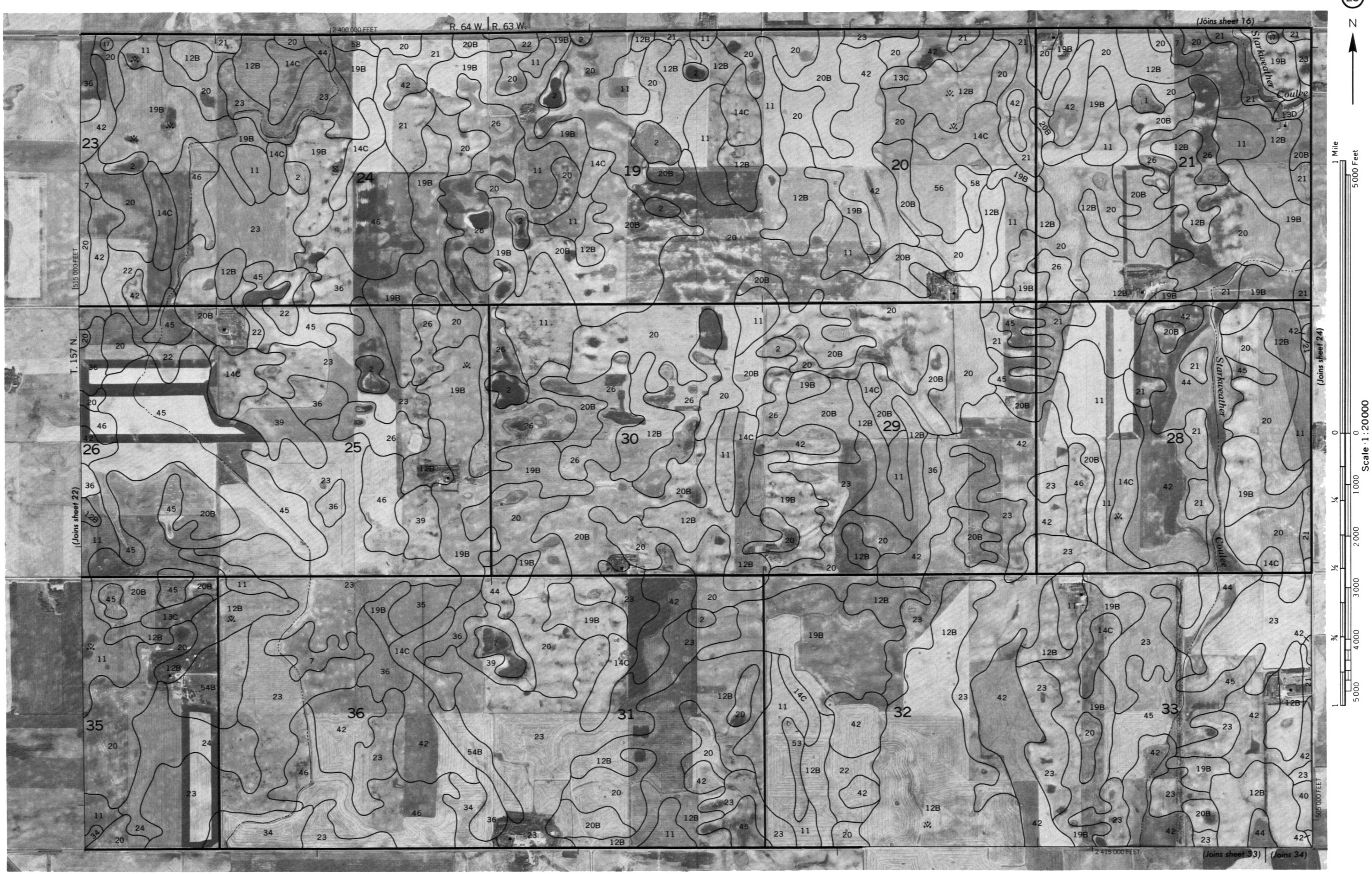


RAMSEY COUNTY, NORTH DAKOTA NO. 21

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

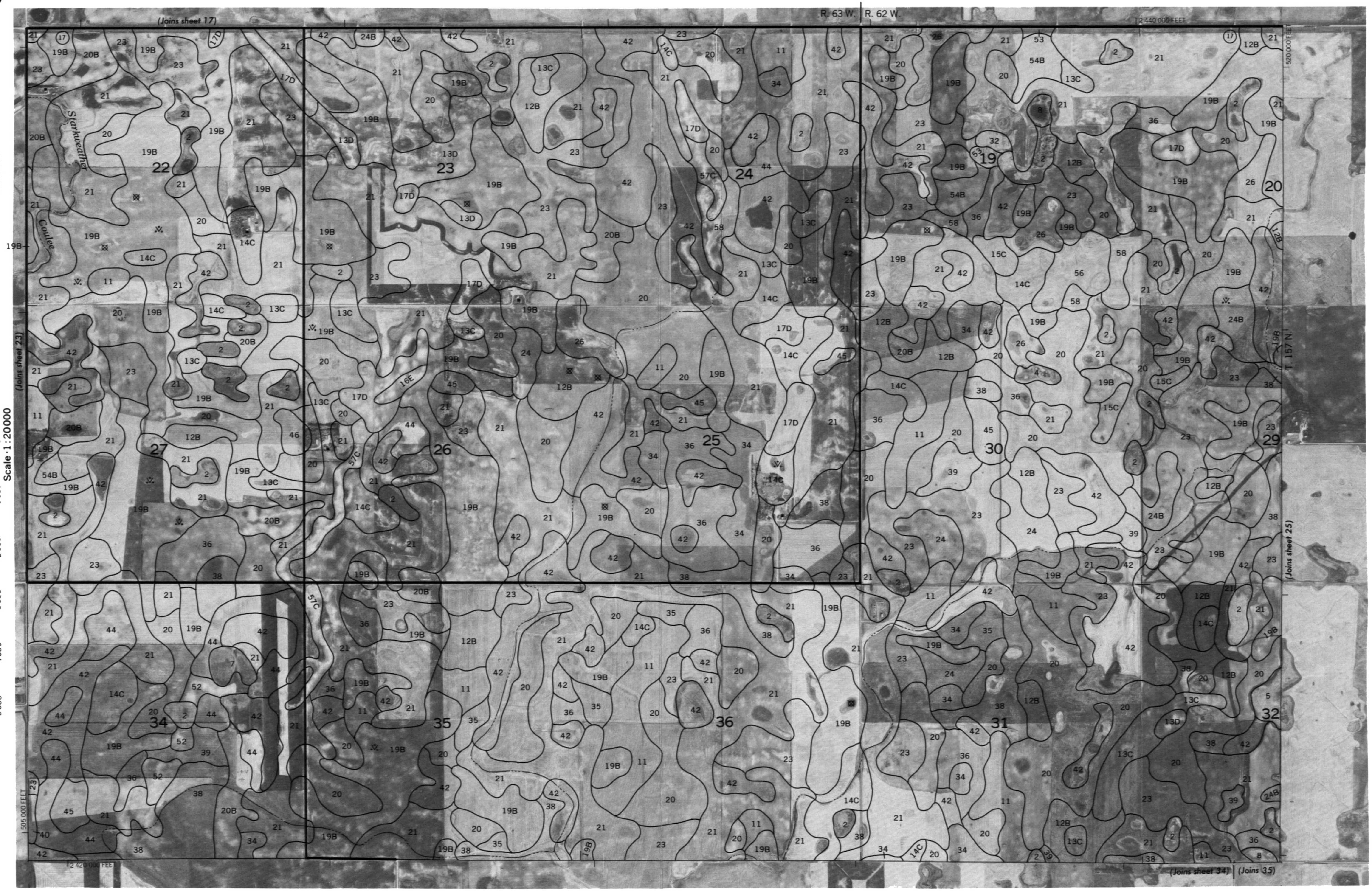


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

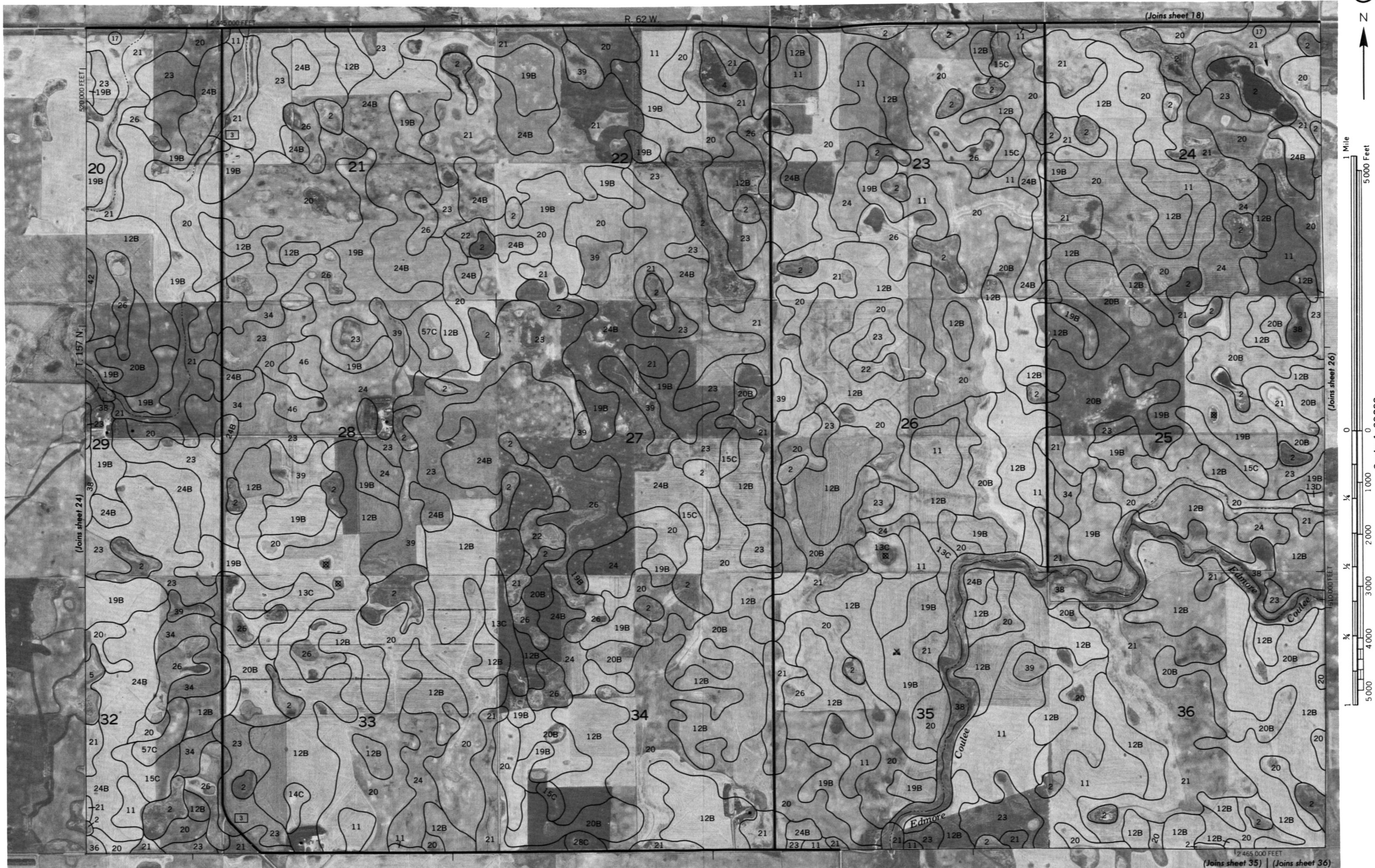


RAMSEY COUNTY, NORTH DAKOTA NO. 23

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

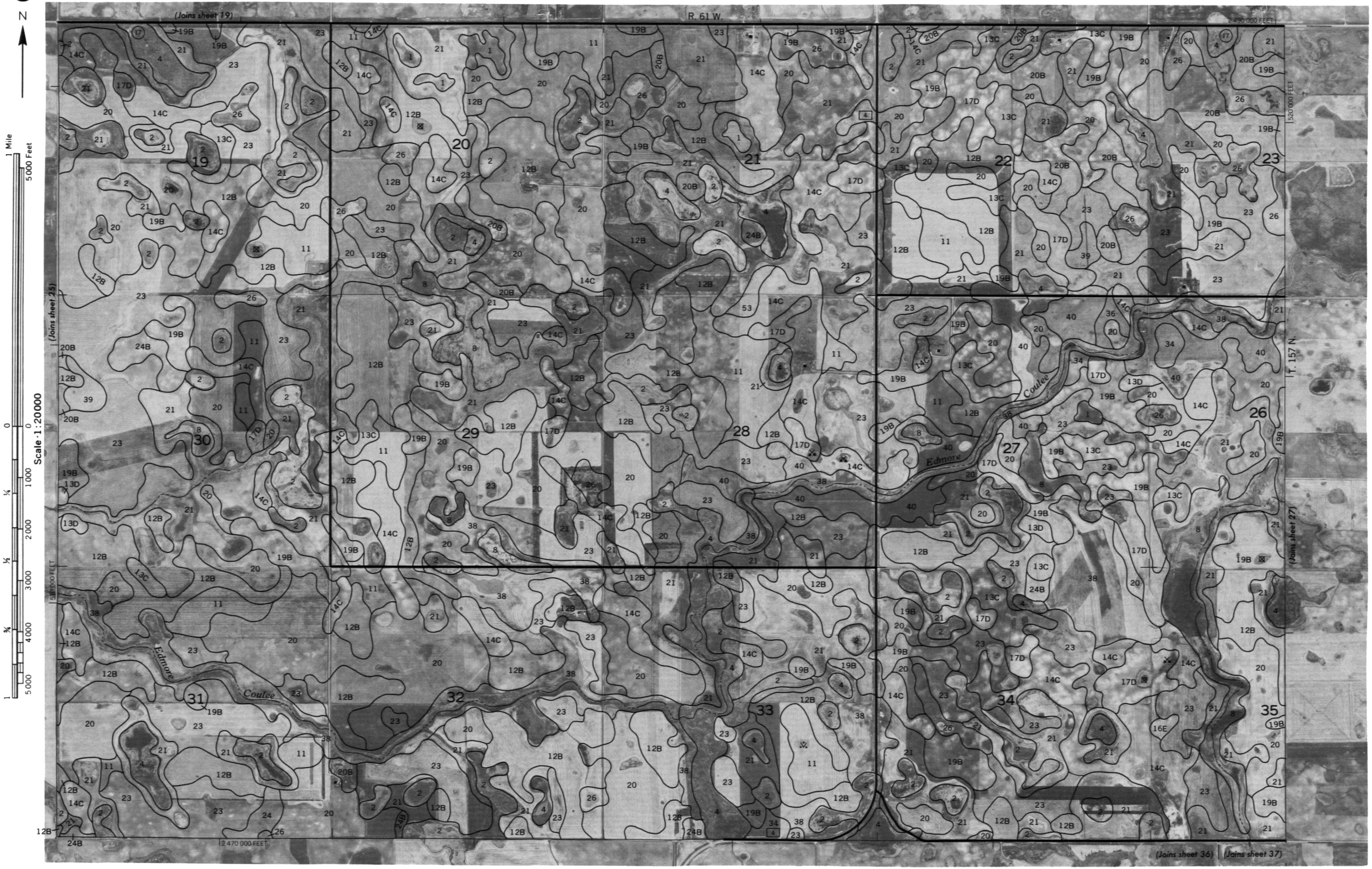


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



RAMSEY COUNTY, NORTH DAKOTA NO. 25

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

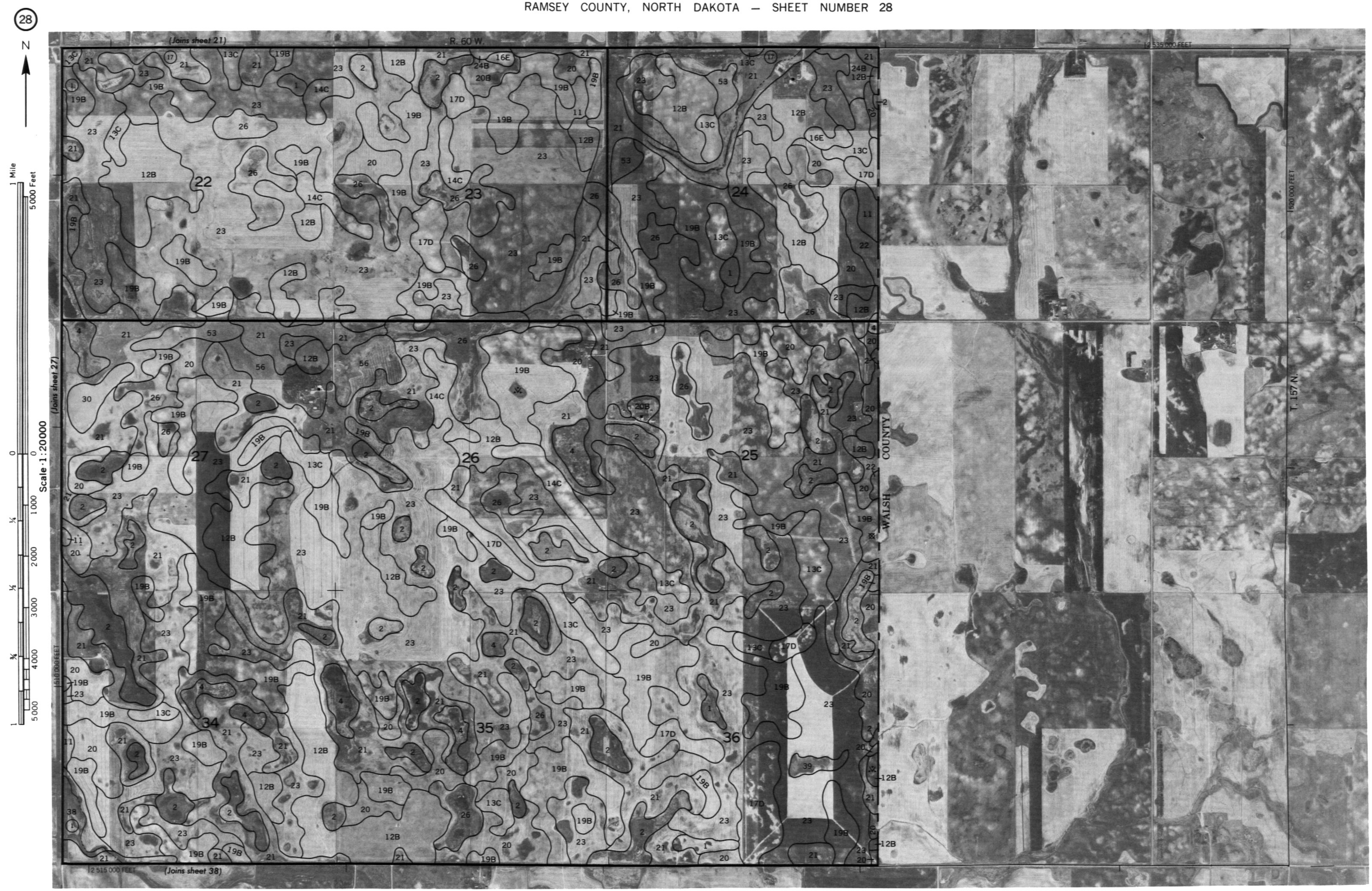


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 26

RAMSEY COUNTY, NORTH DAKOTA NO. 27

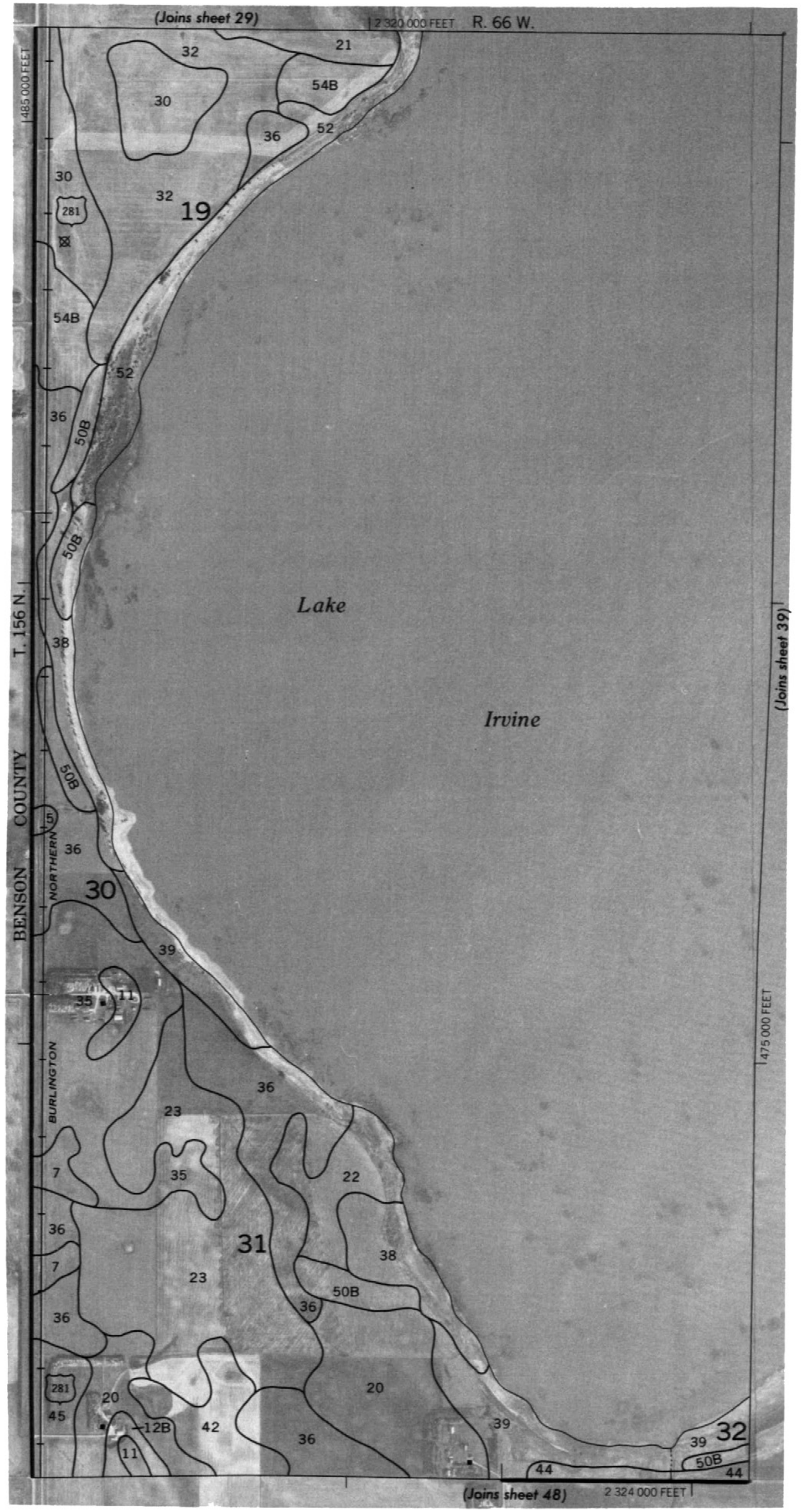
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 28

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

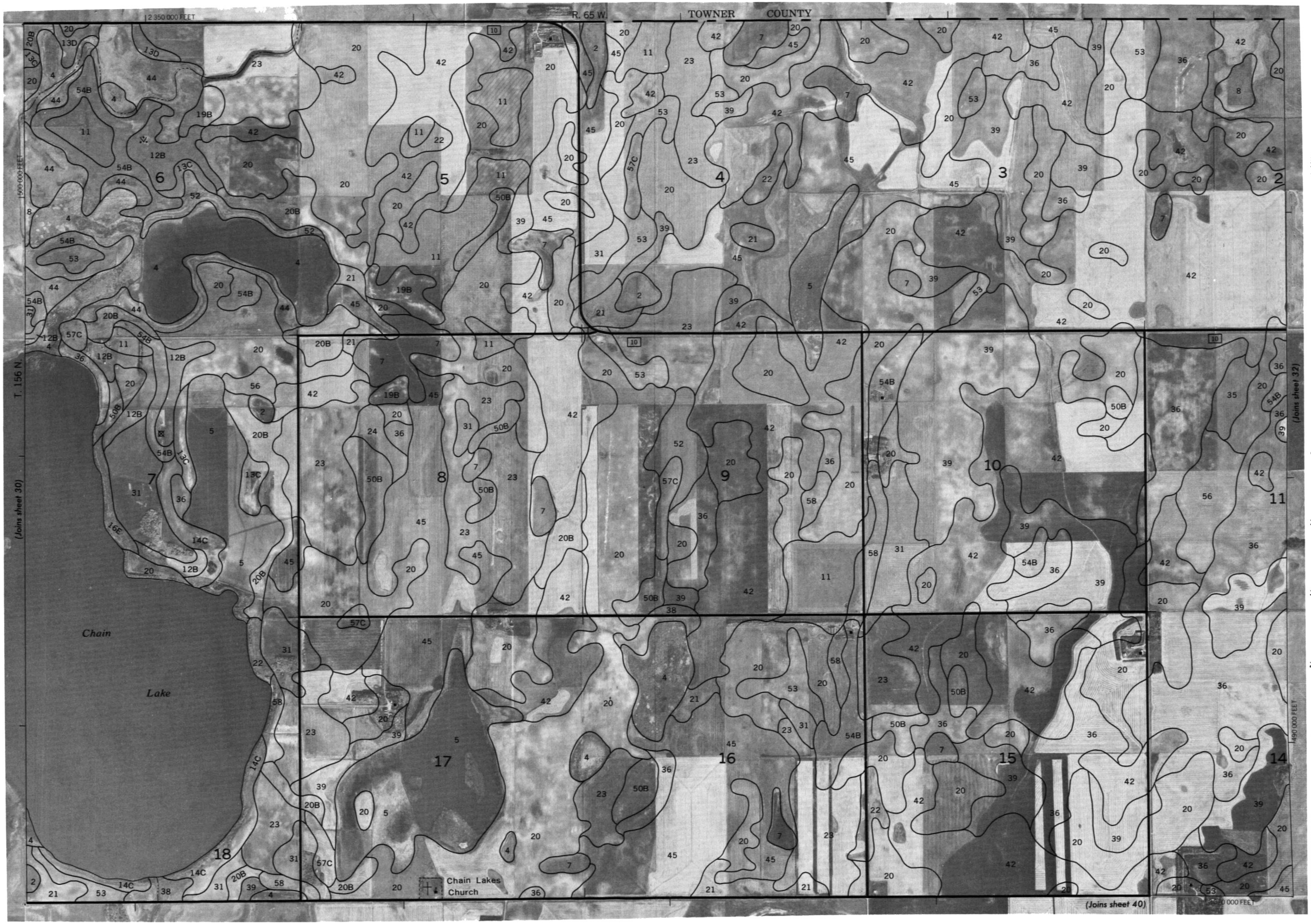


4000 AND 5000-FOOT GRID TICKS

(30)

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 31



31

N

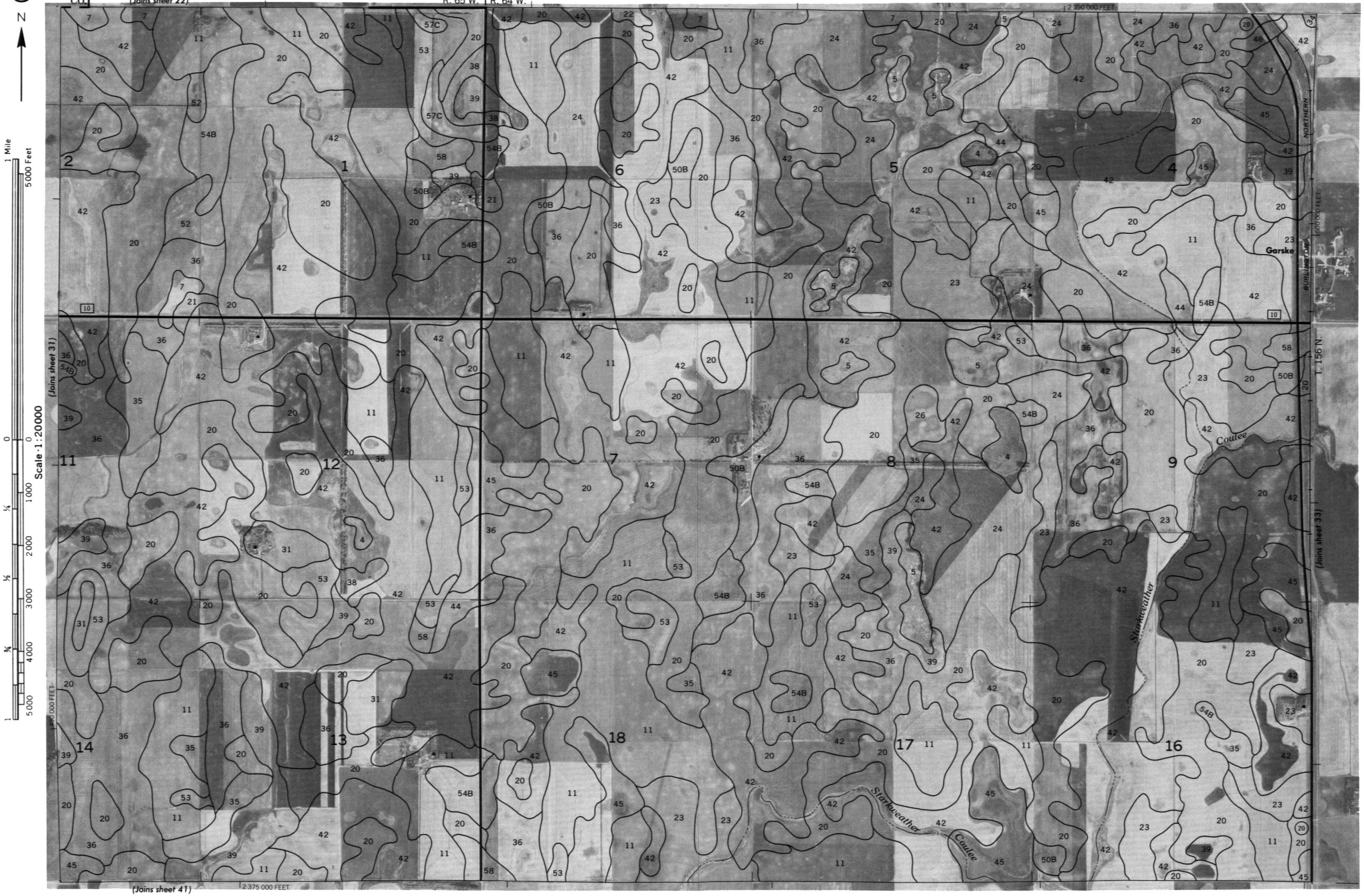
Scale 1:20000

1 Mile

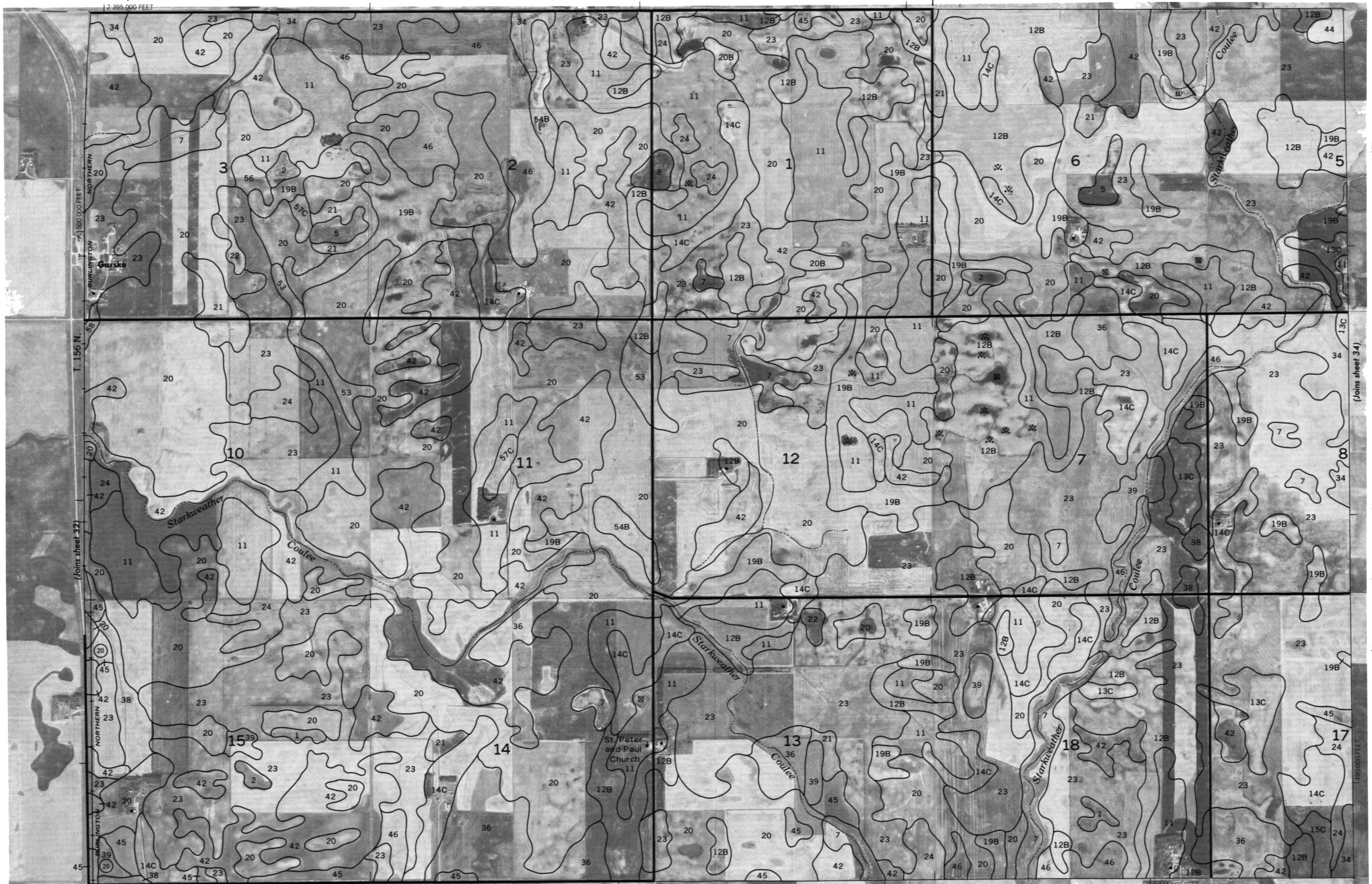
5000 Feet

RAMSEY COUNTY, NORTH DAKOTA NO. 31

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

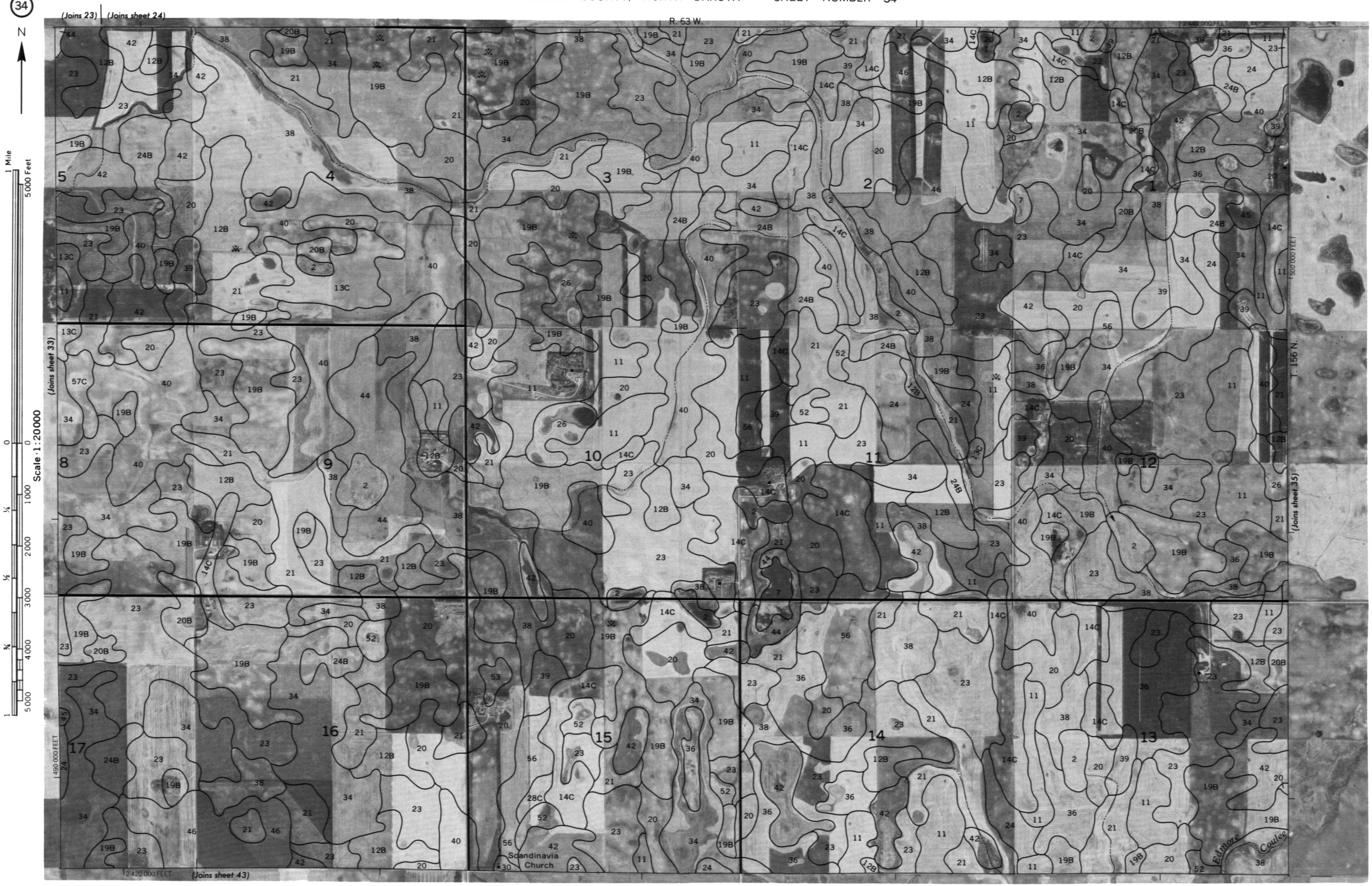


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



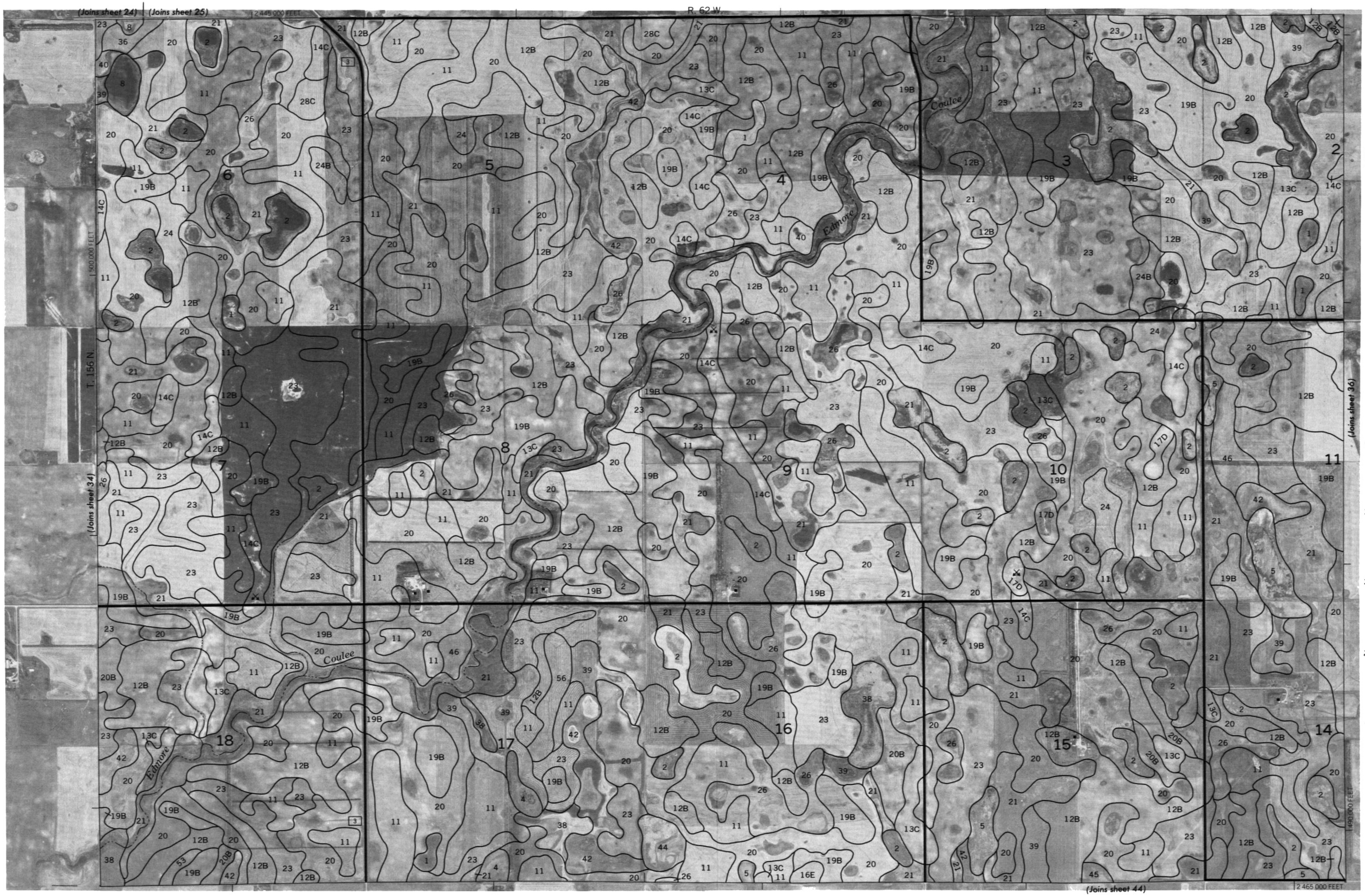
RAMSEY COUNTY, NORTH DAKOTA NO. 33

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



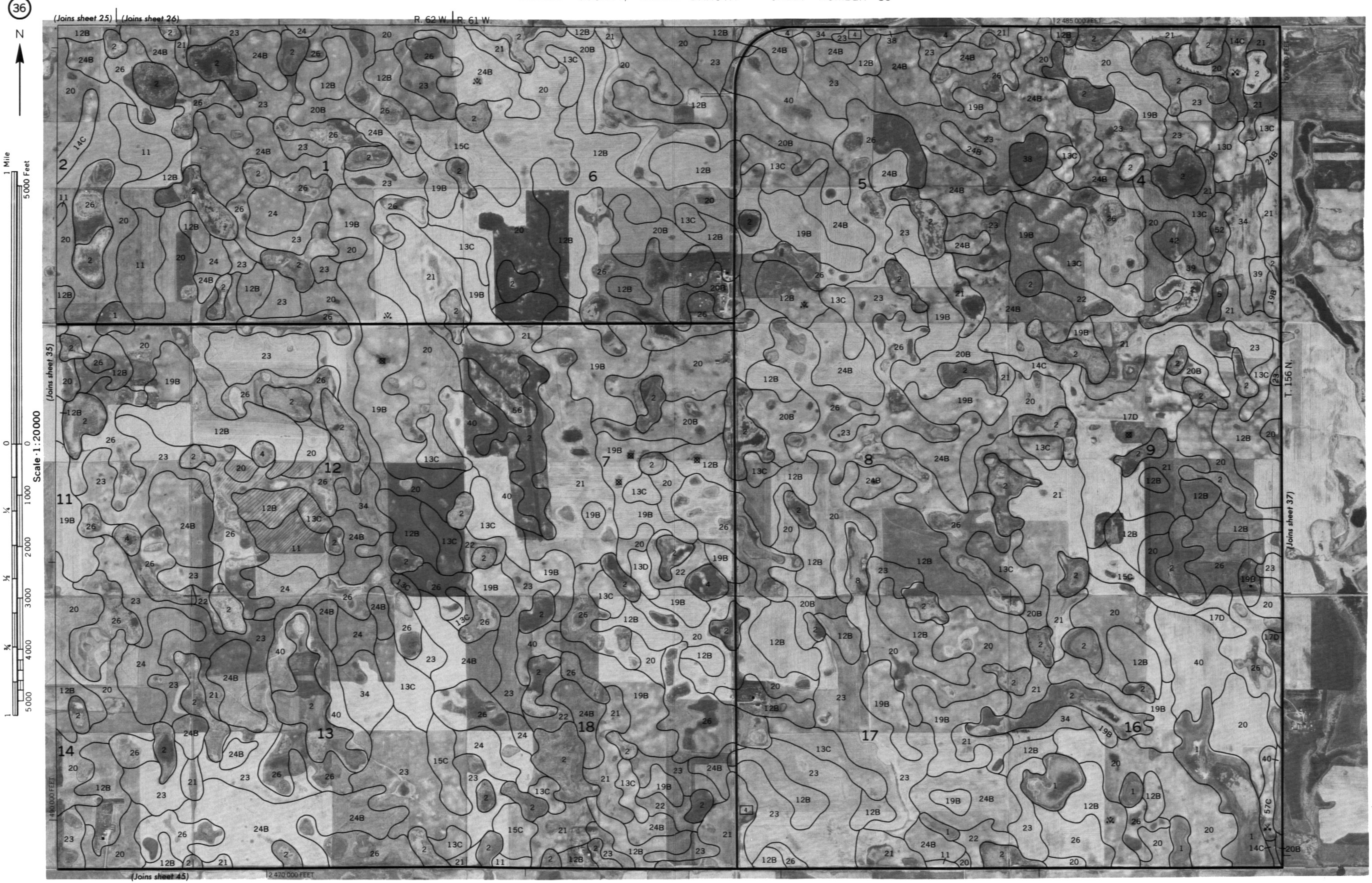
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 34

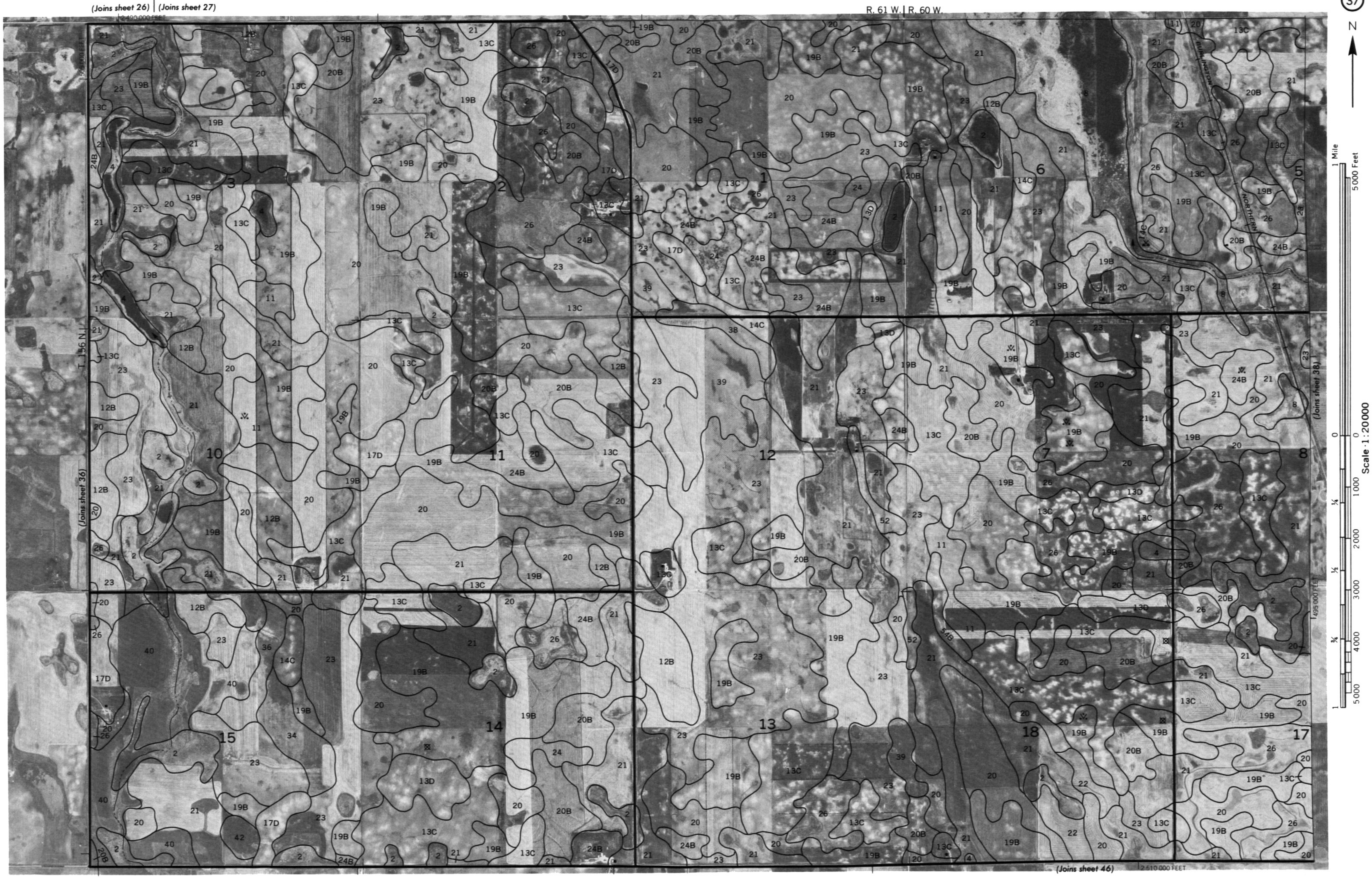


RAMSEY COUNTY, NORTH DAKOTA NO. 35

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

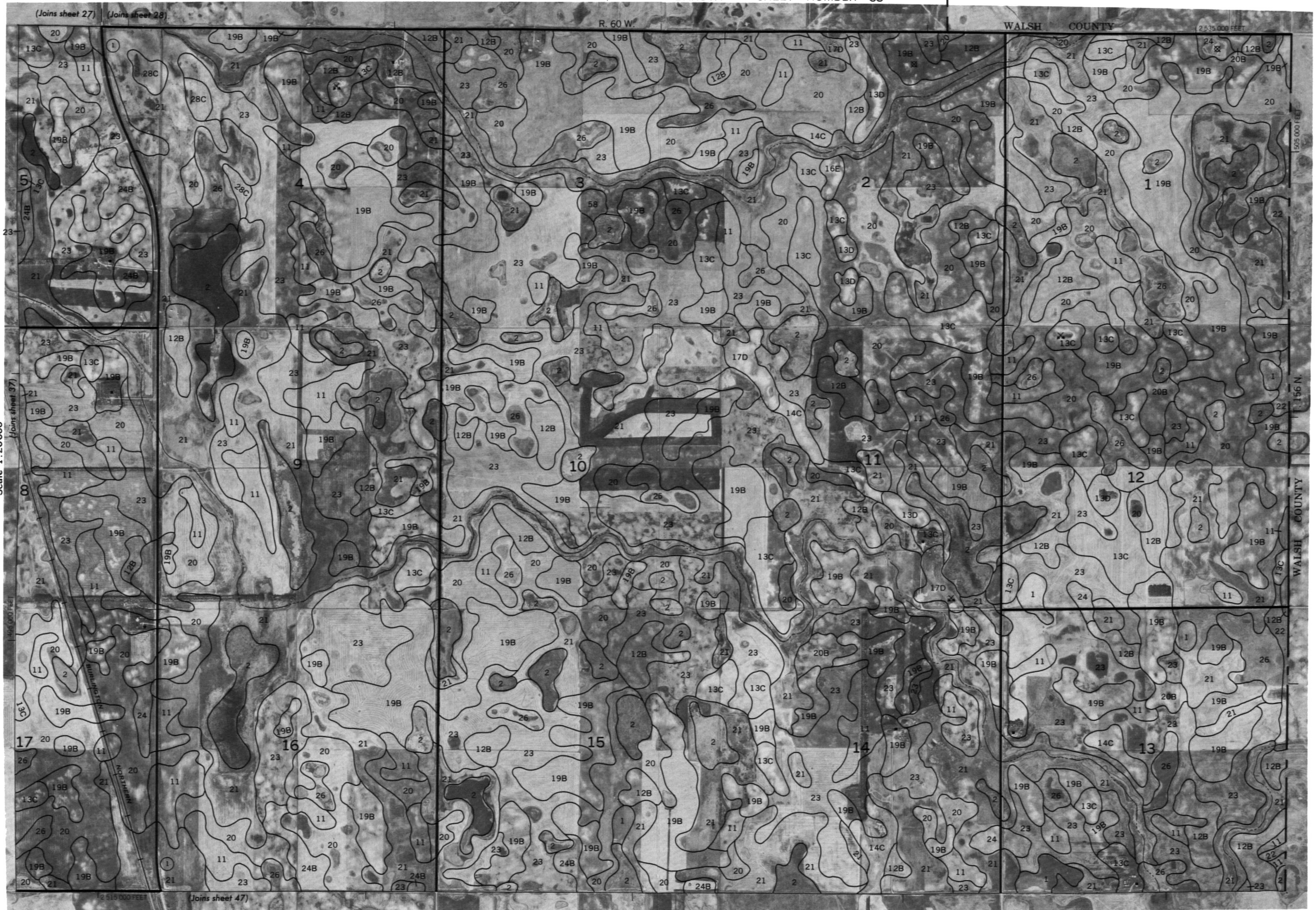


RAMSEY COUNTY, NORTH DAKOTA NO. 37

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

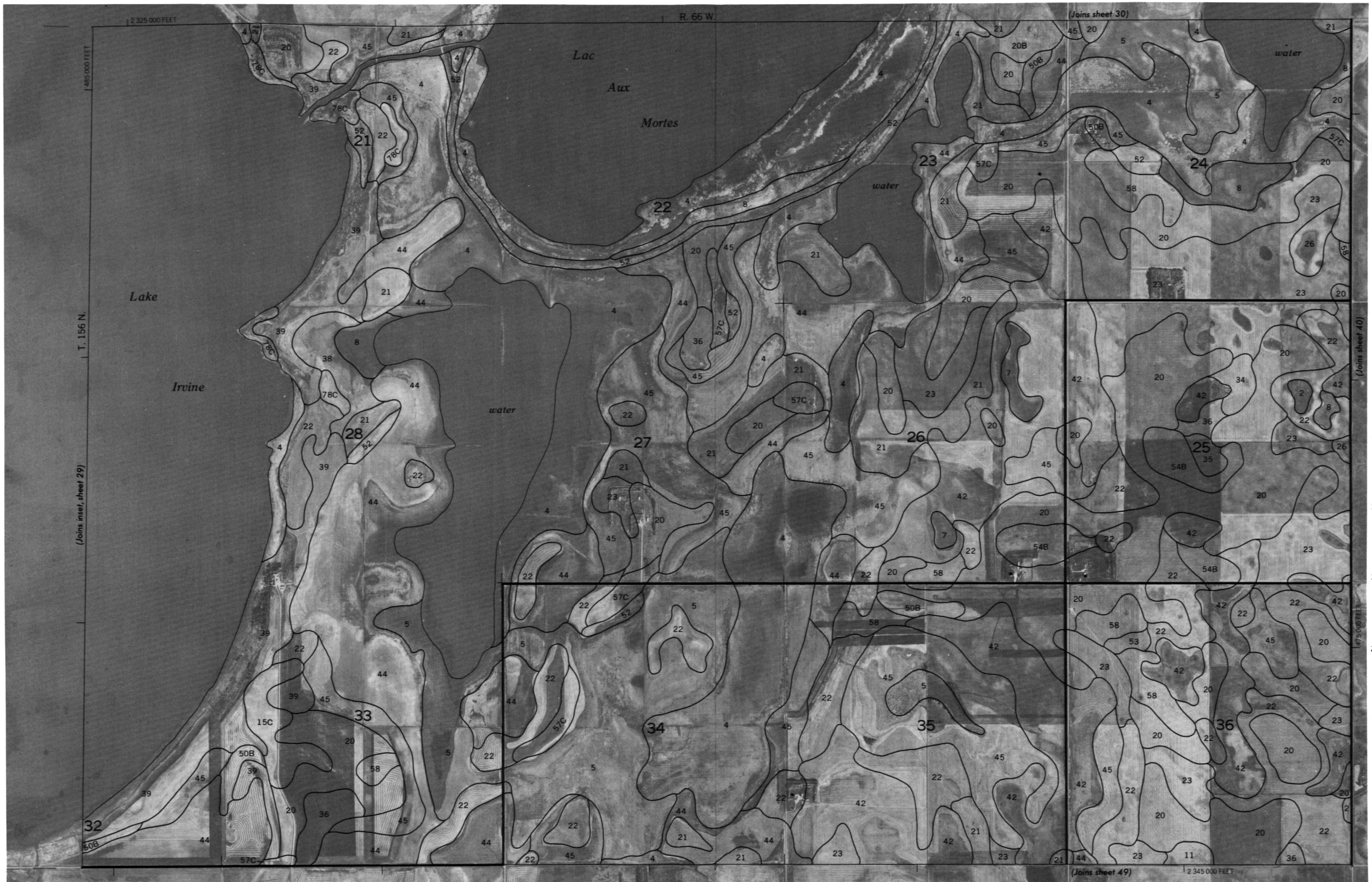
N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

39

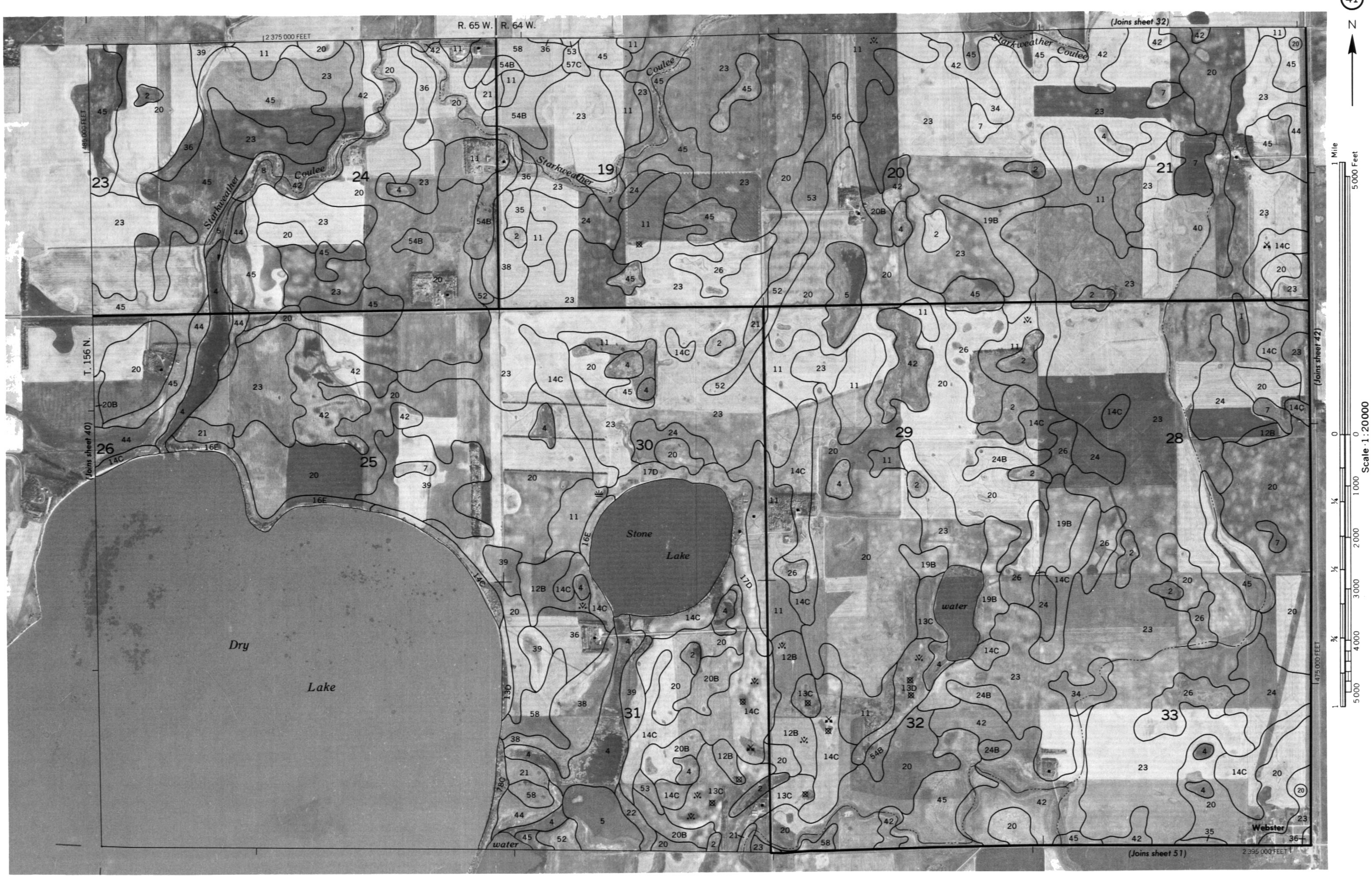


1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 39

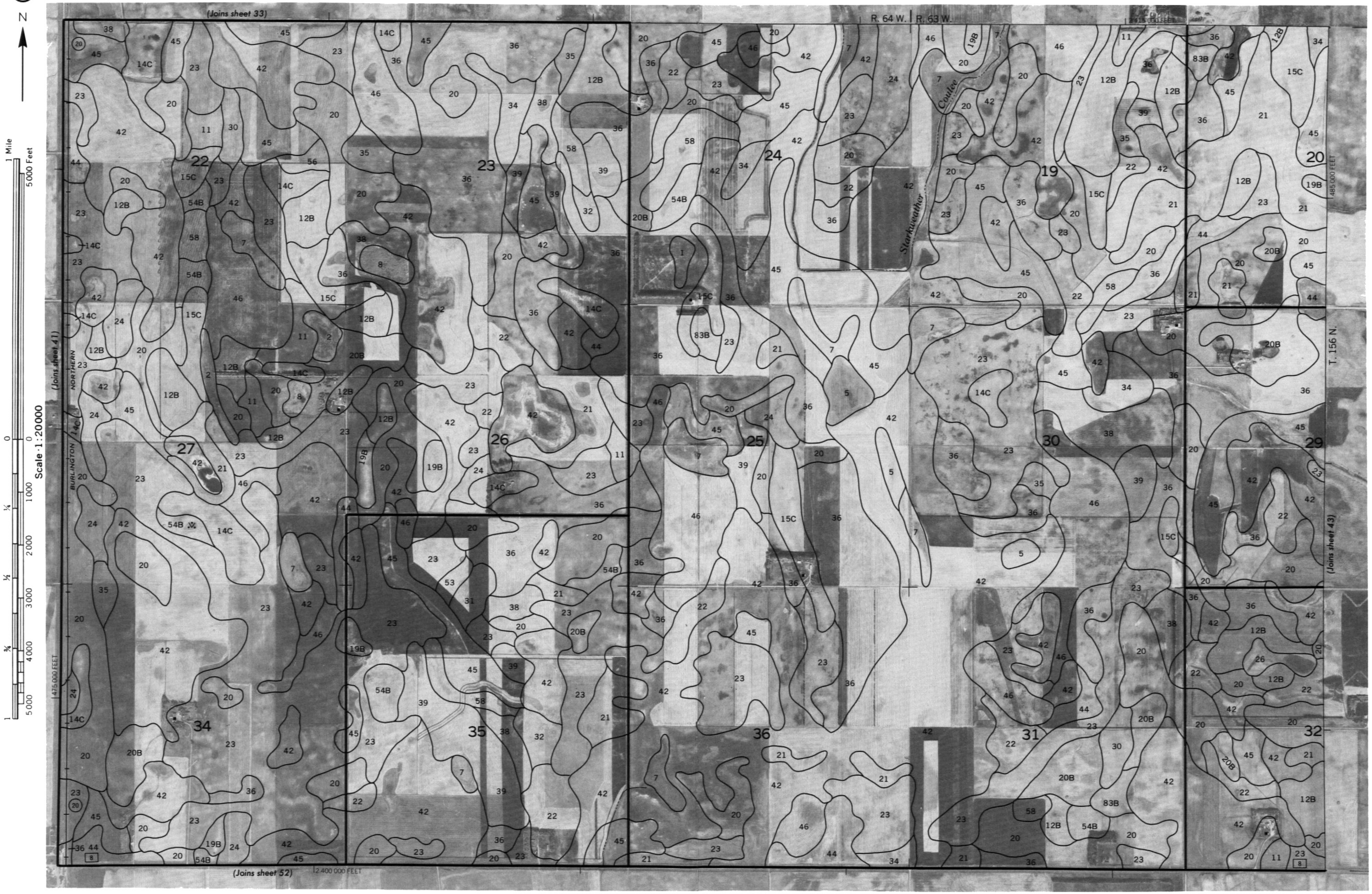
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



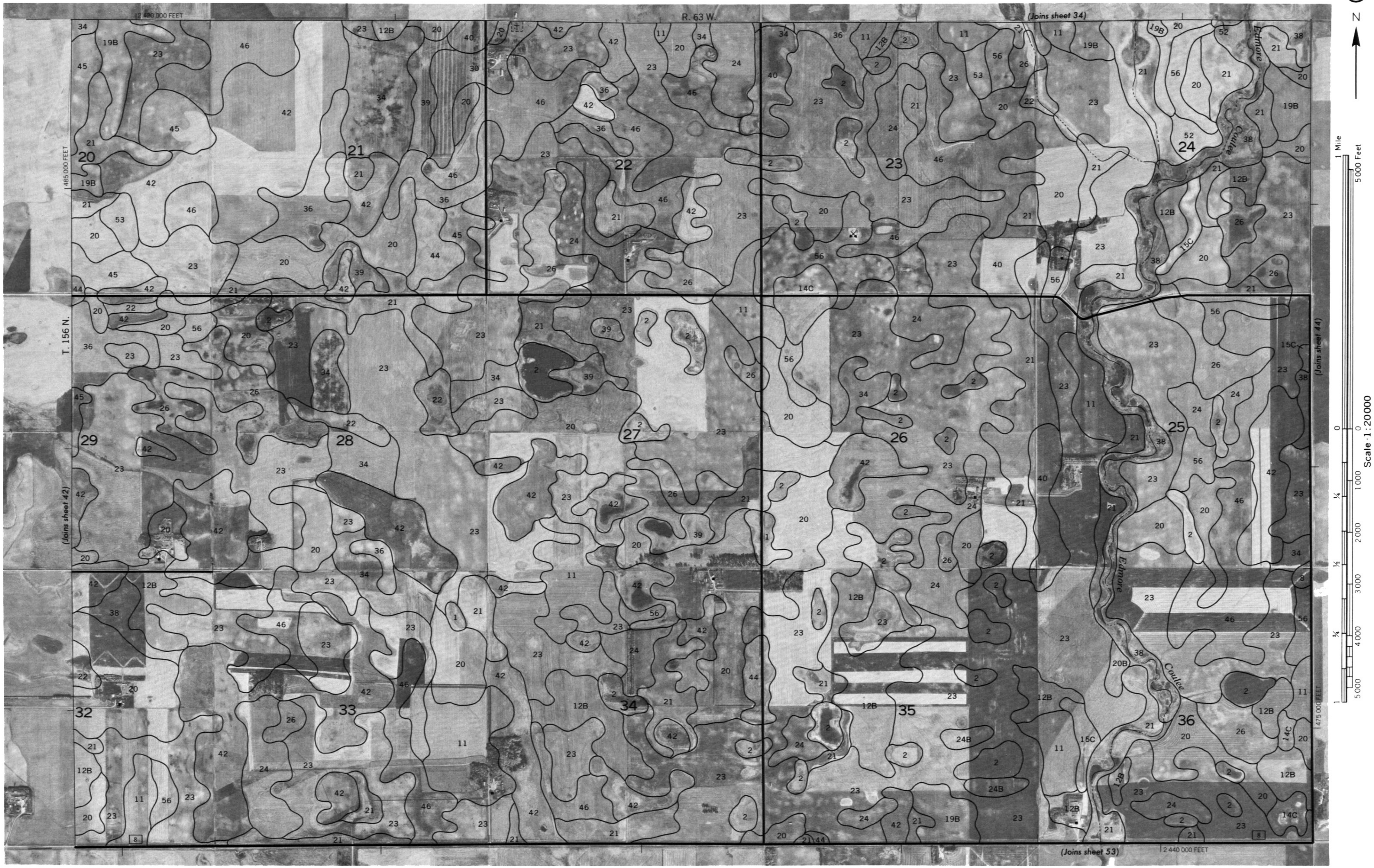
RAMSEY COUNTY, NORTH DAKOTA NO. 41

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



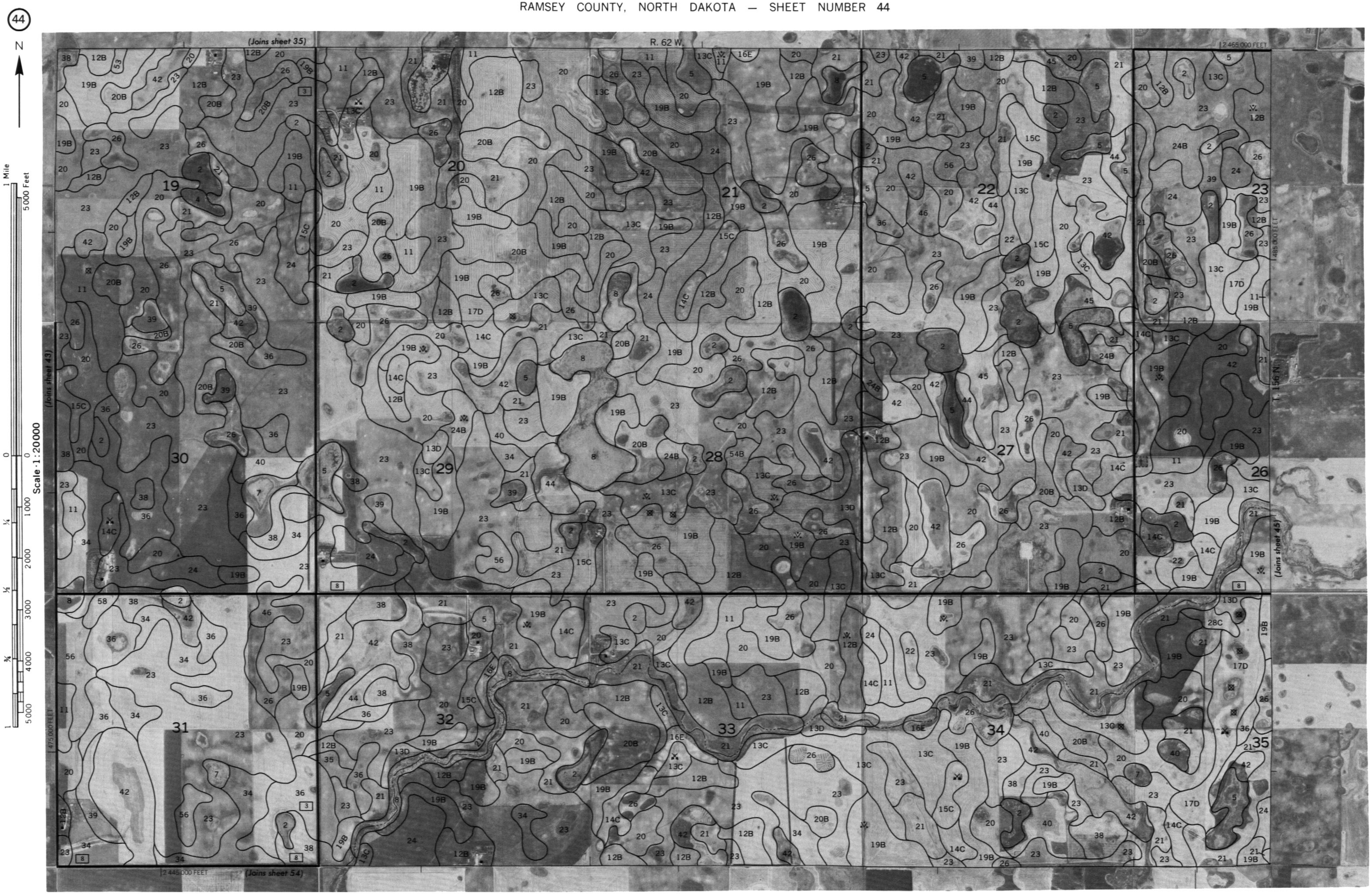
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 42



RAMSEY COUNTY, NORTH DAKOTA NO. 43

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

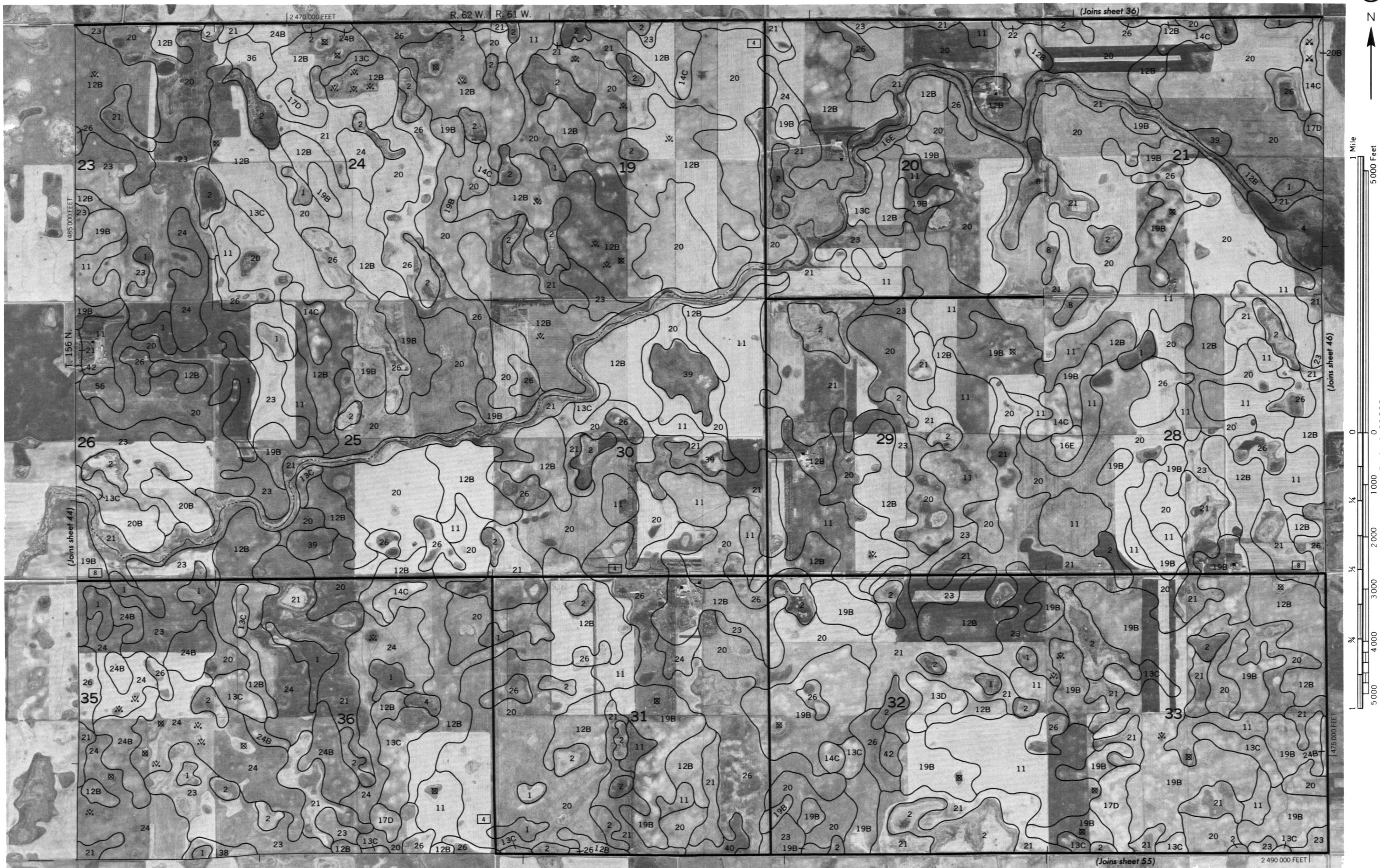


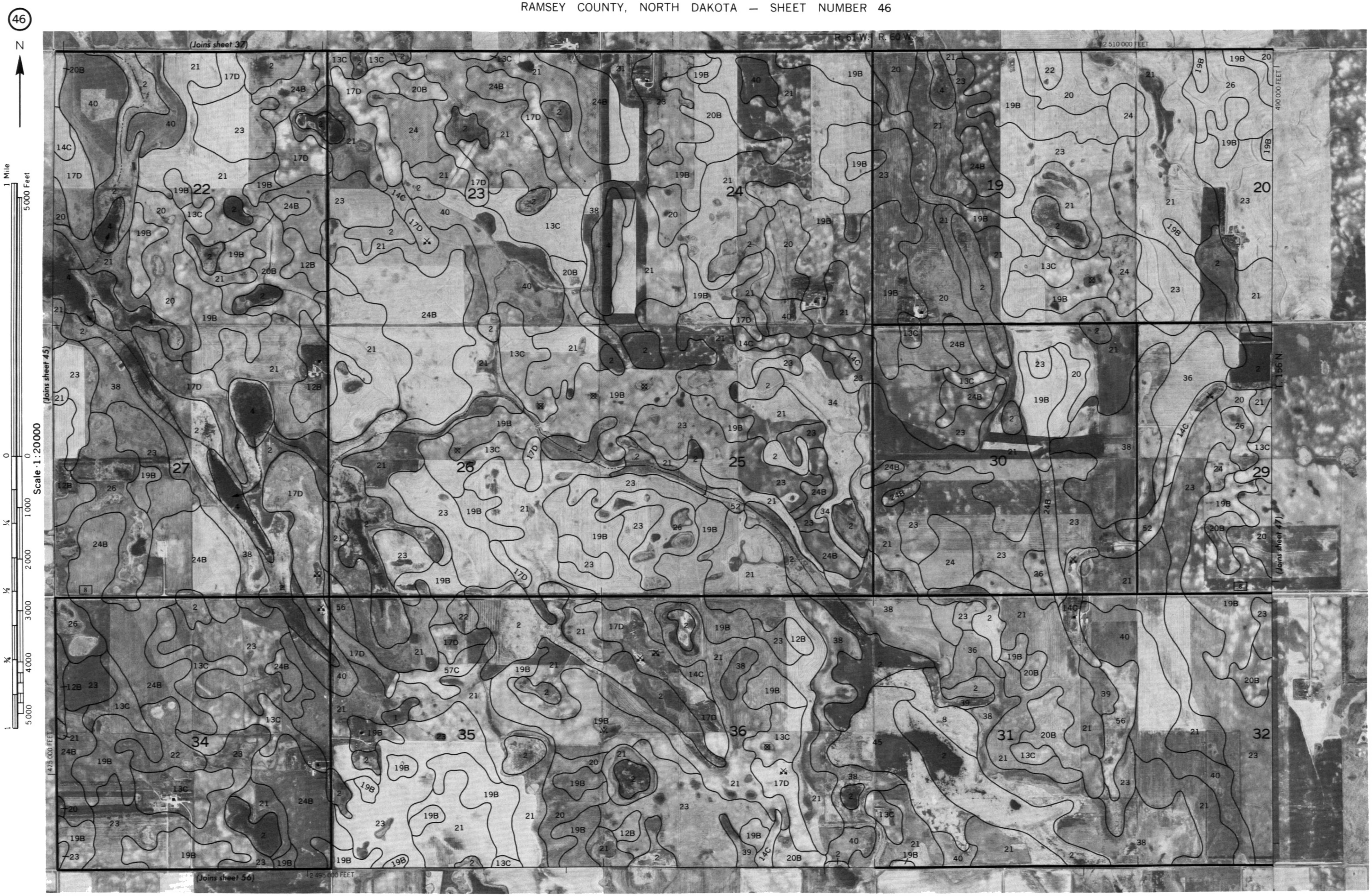
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 44

RAMSEY COUNTY, NORTH DAKOTA NO. 45

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

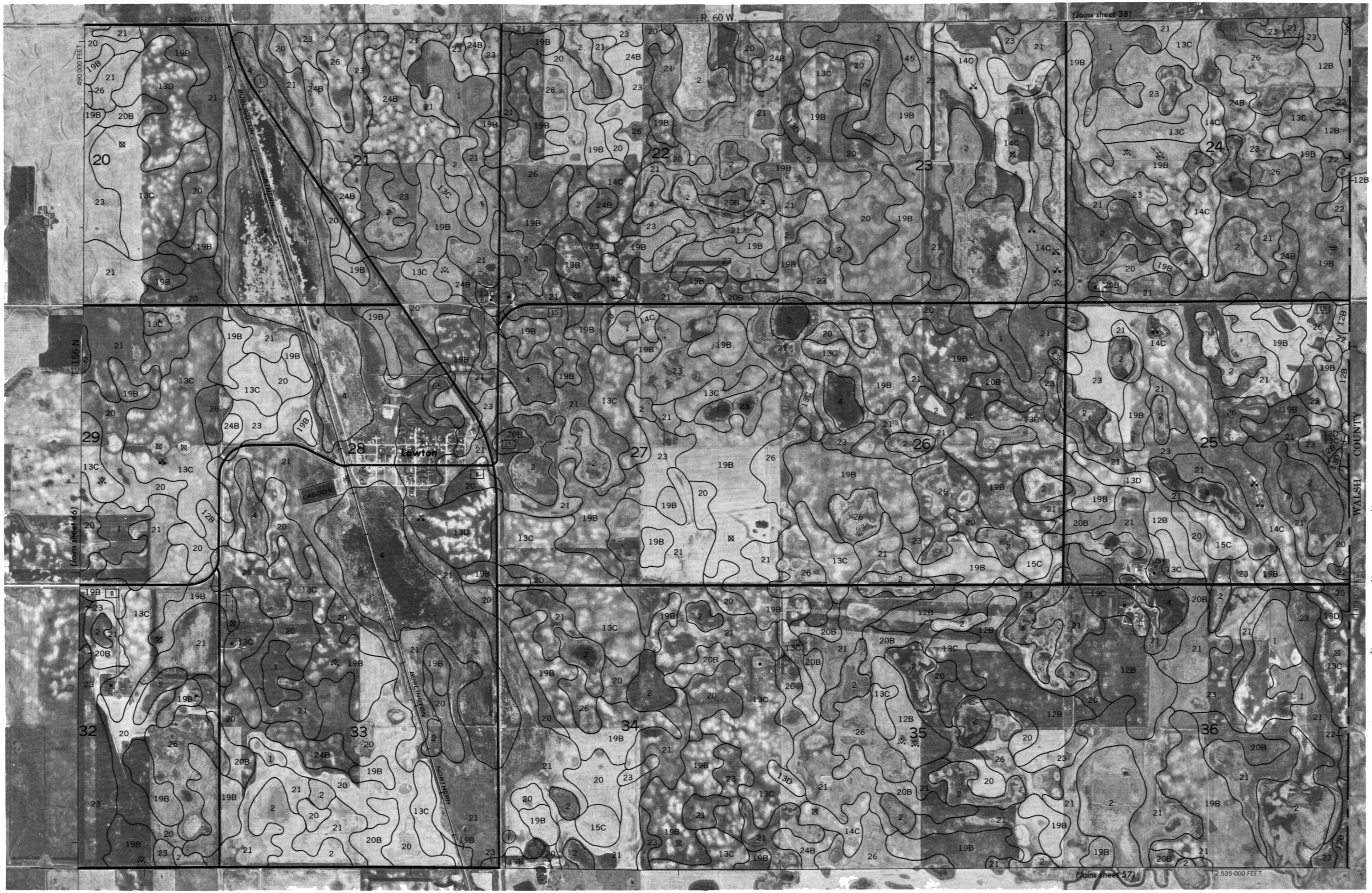




This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 46

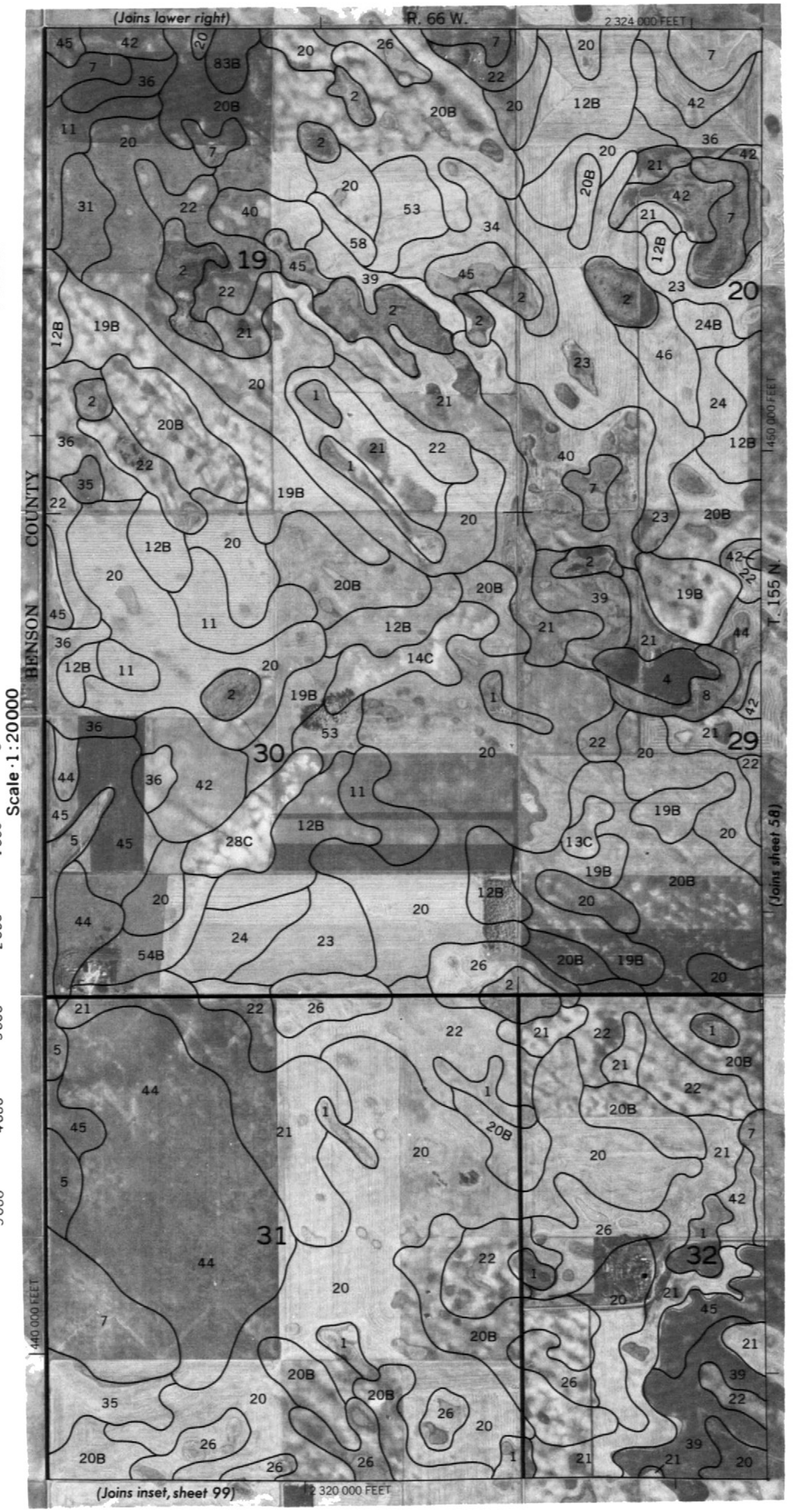
N

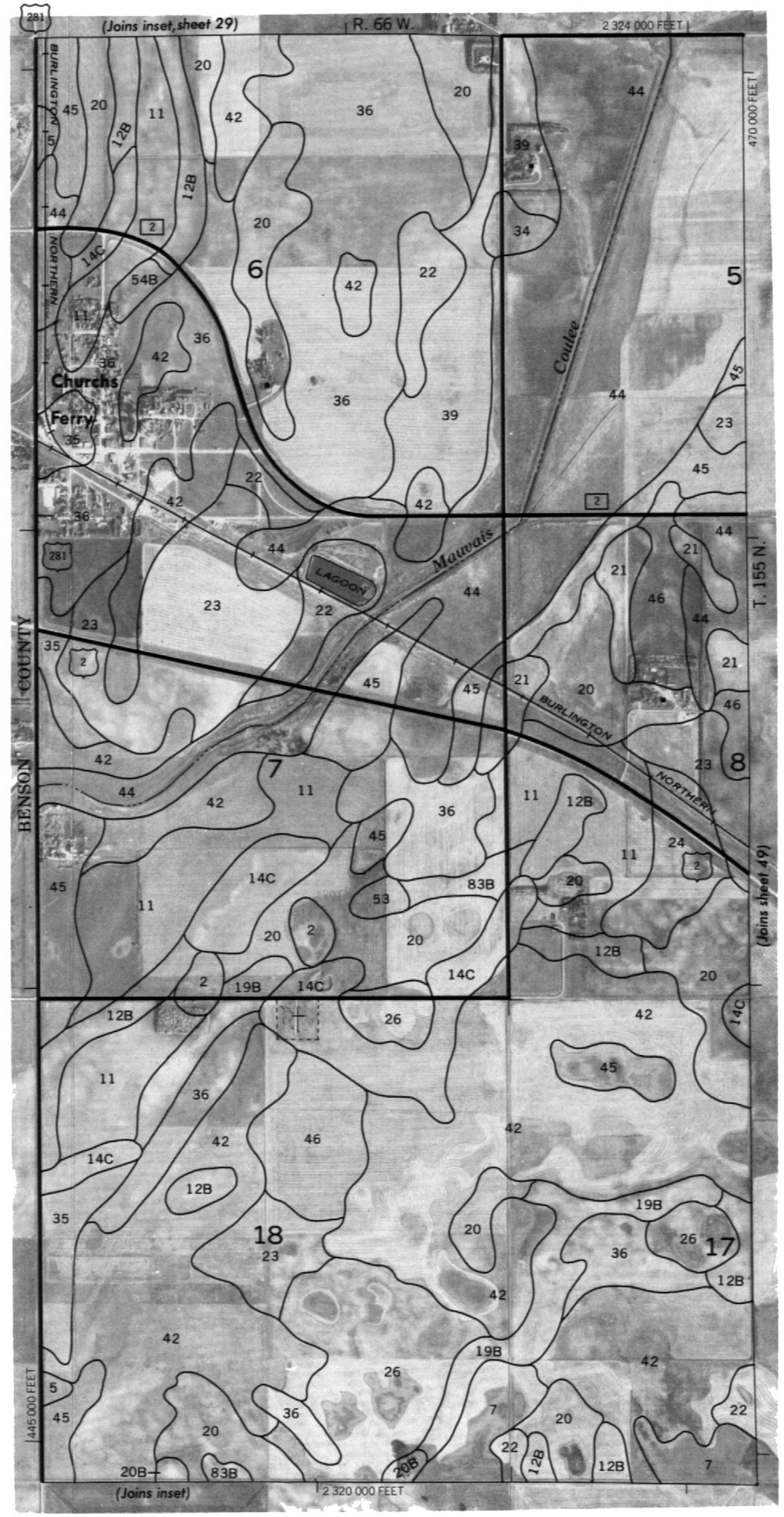


1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 47

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



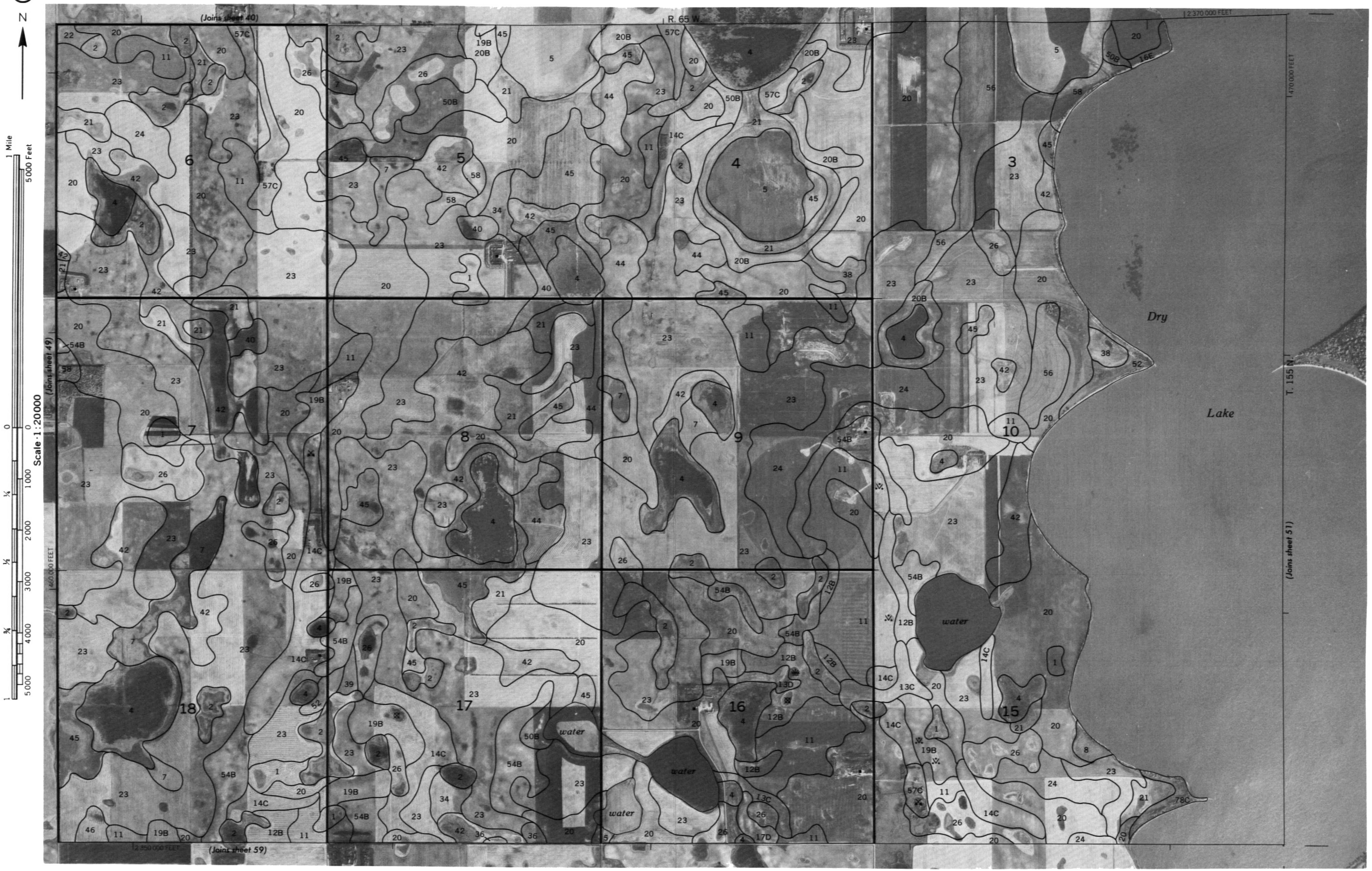


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

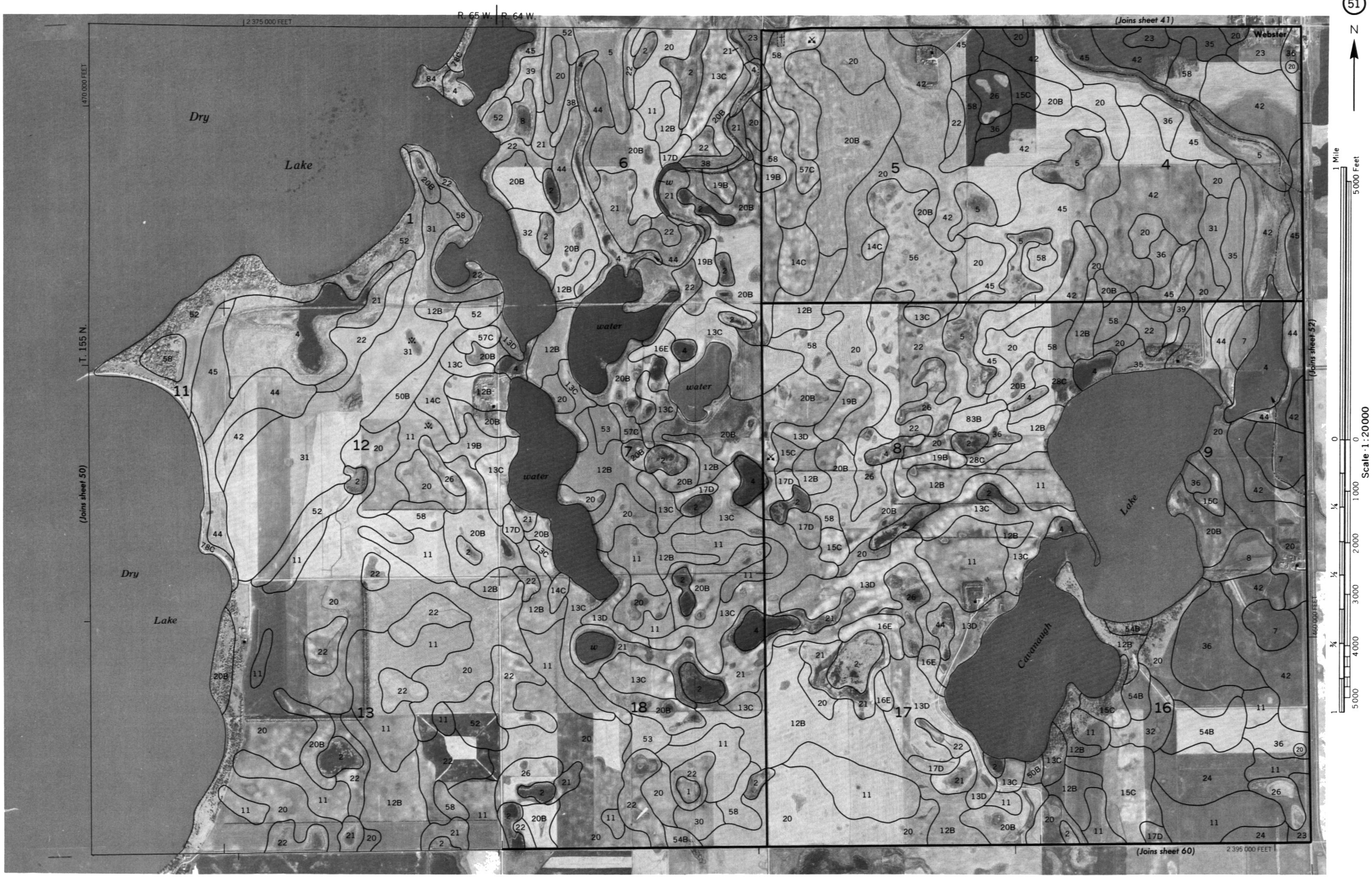
RAMSEY COUNTY, NORTH DAKOTA NO. 48

RAMSEY COUNTY, NORTH DAKOTA NO. 49

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



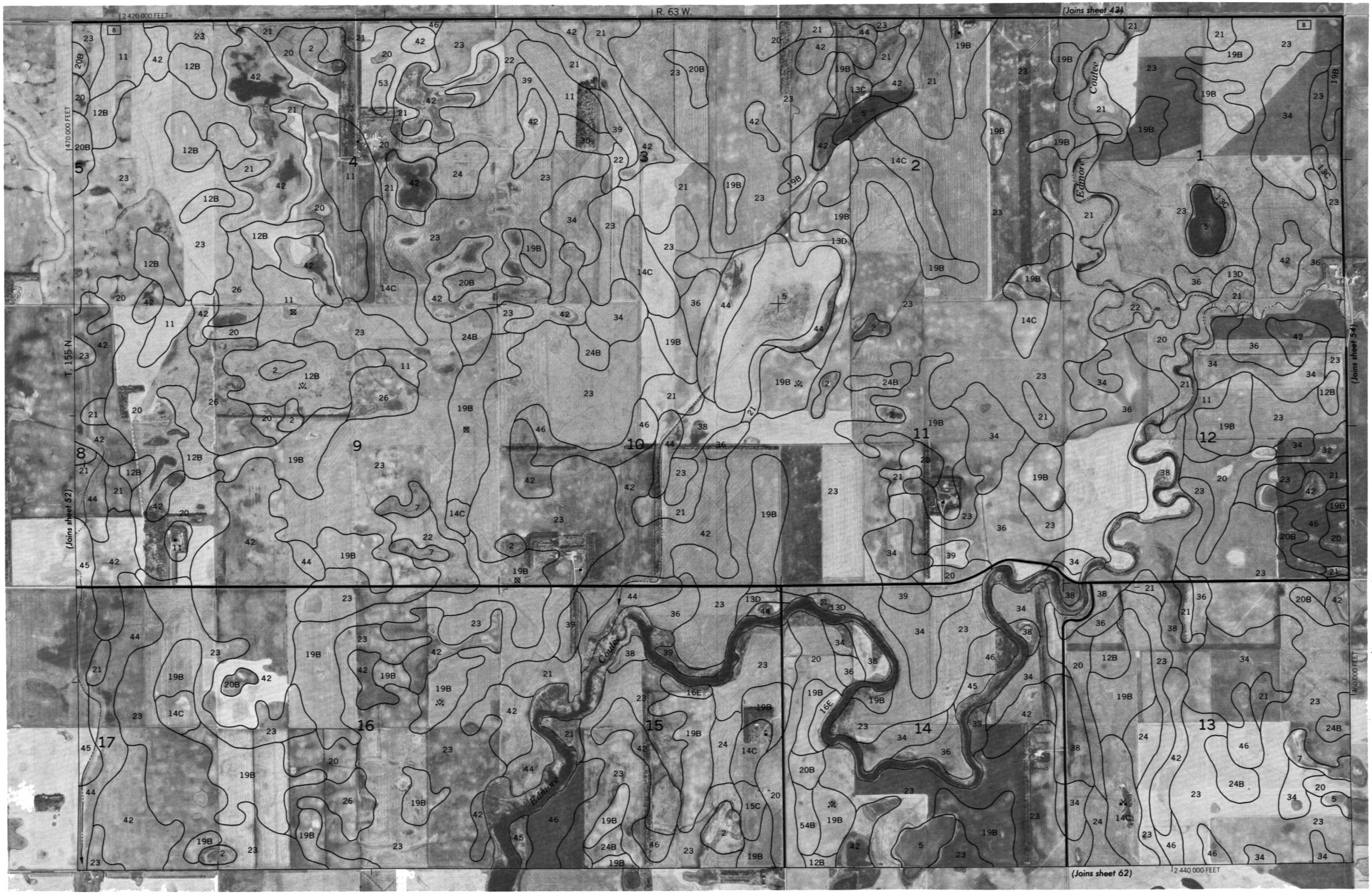
RAMSEY COUNTY, NORTH DAKOTA NO. 51

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

53

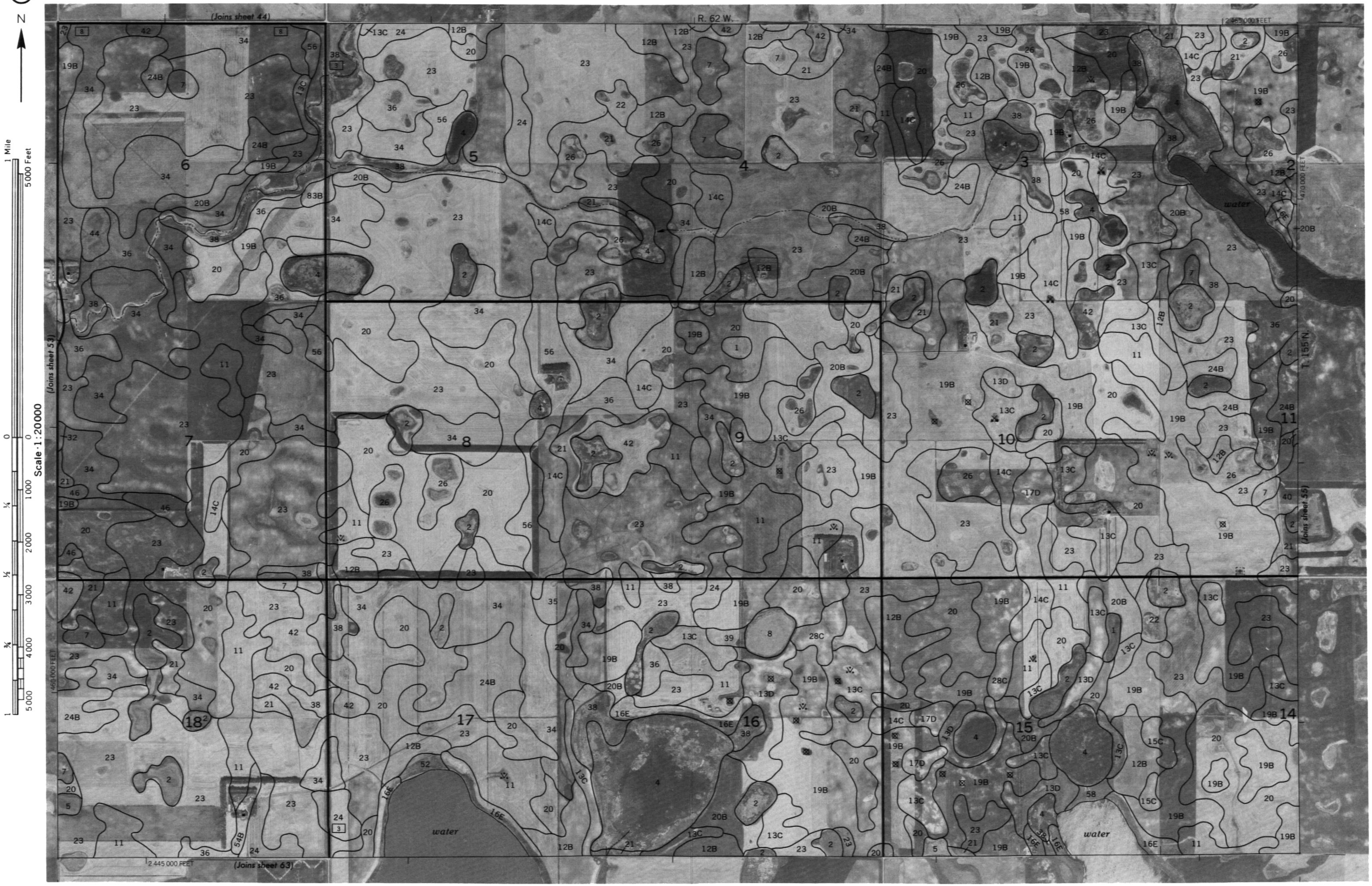
N



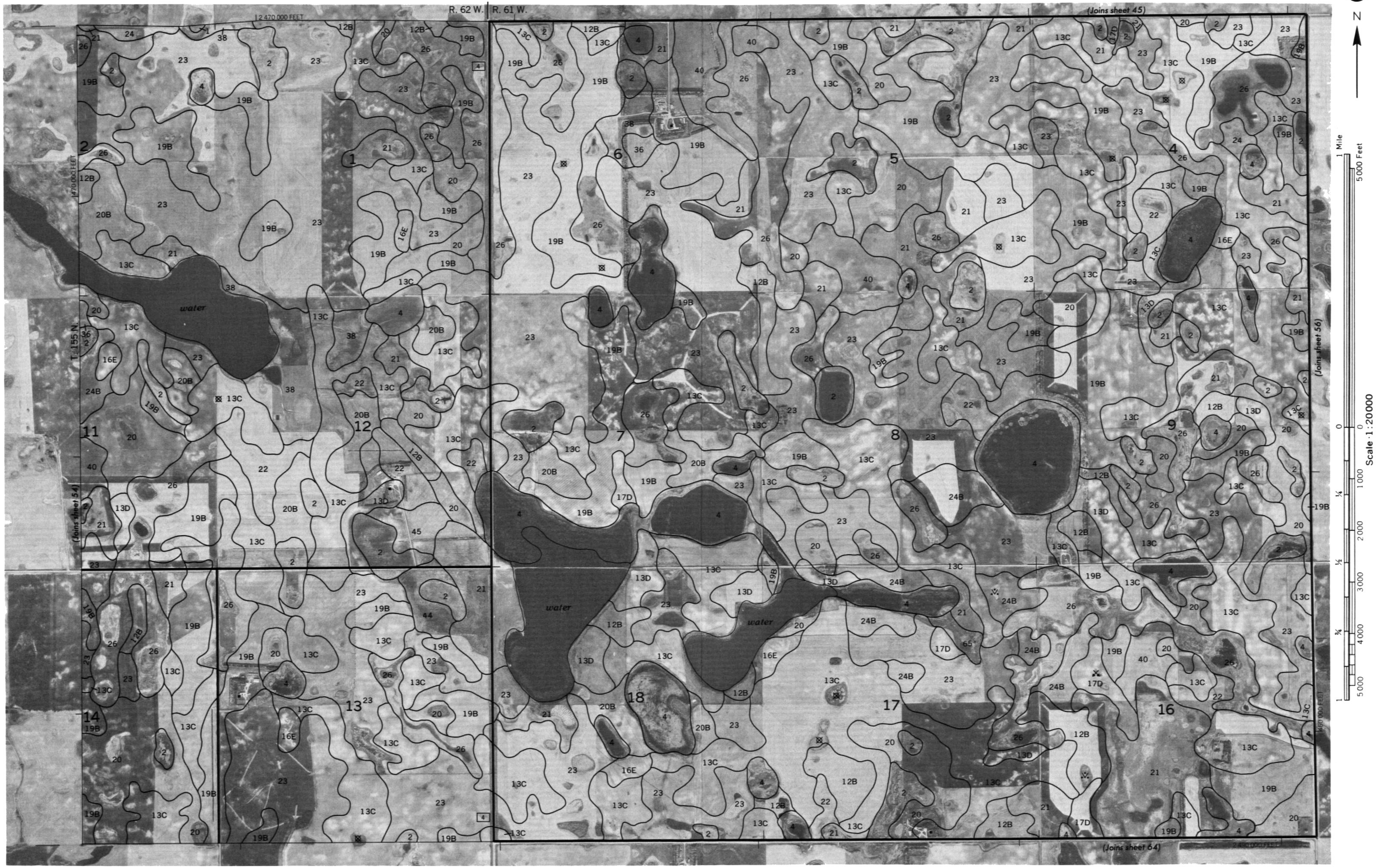
1 Mile
5000 Feet
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000
Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 53

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

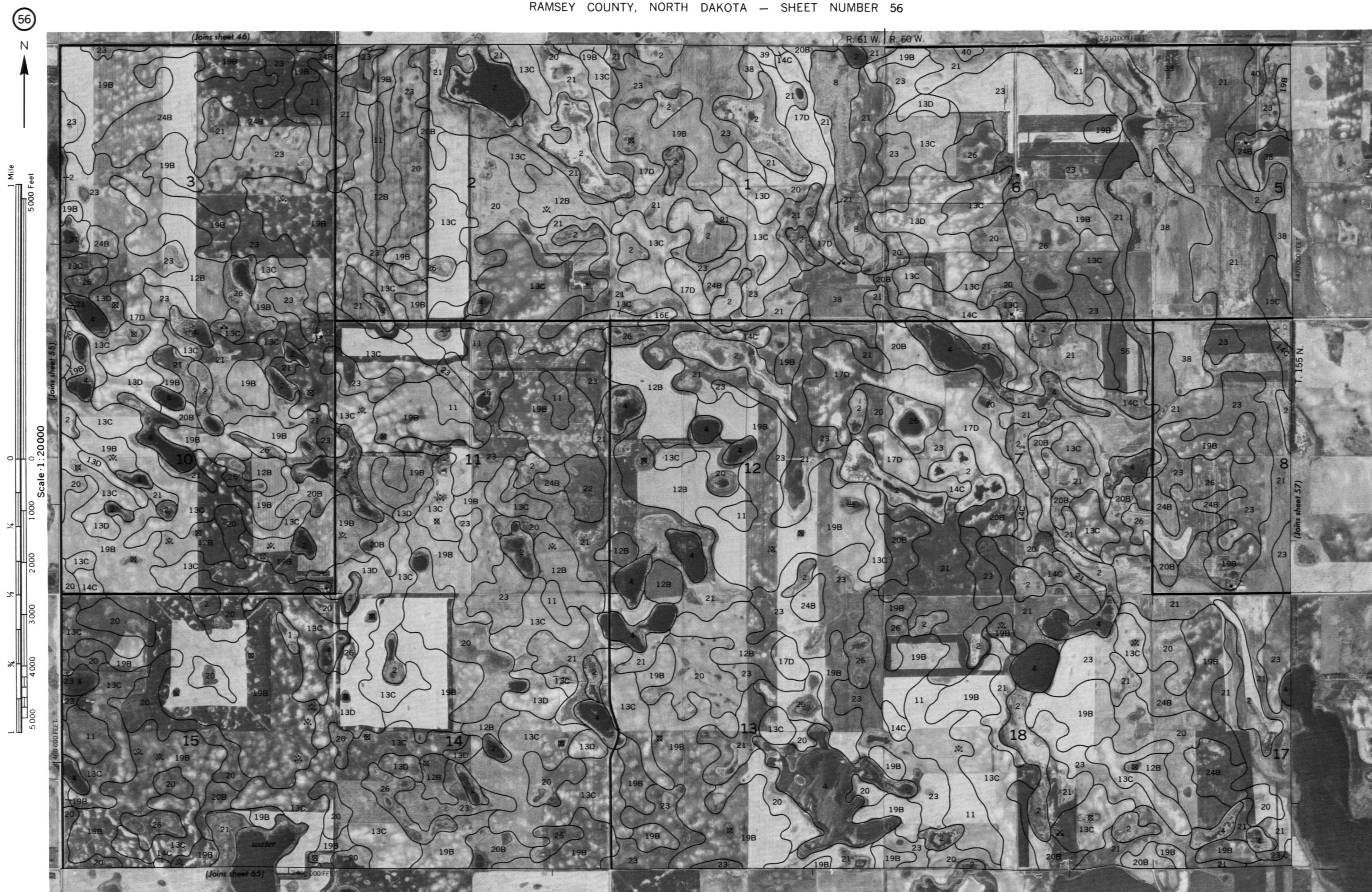


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



RAMSEY COUNTY, NORTH DAKOTA NO. 55

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

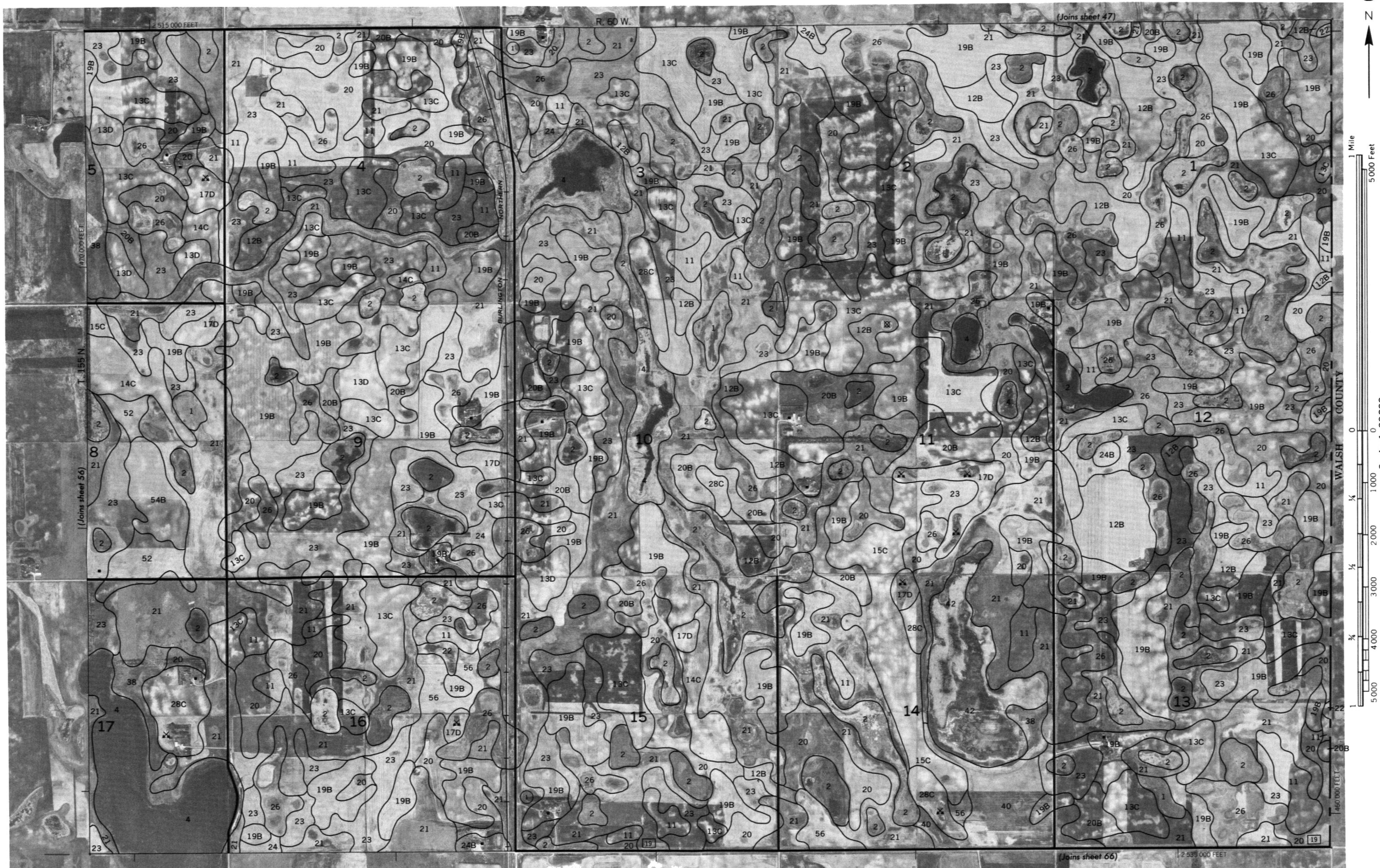


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

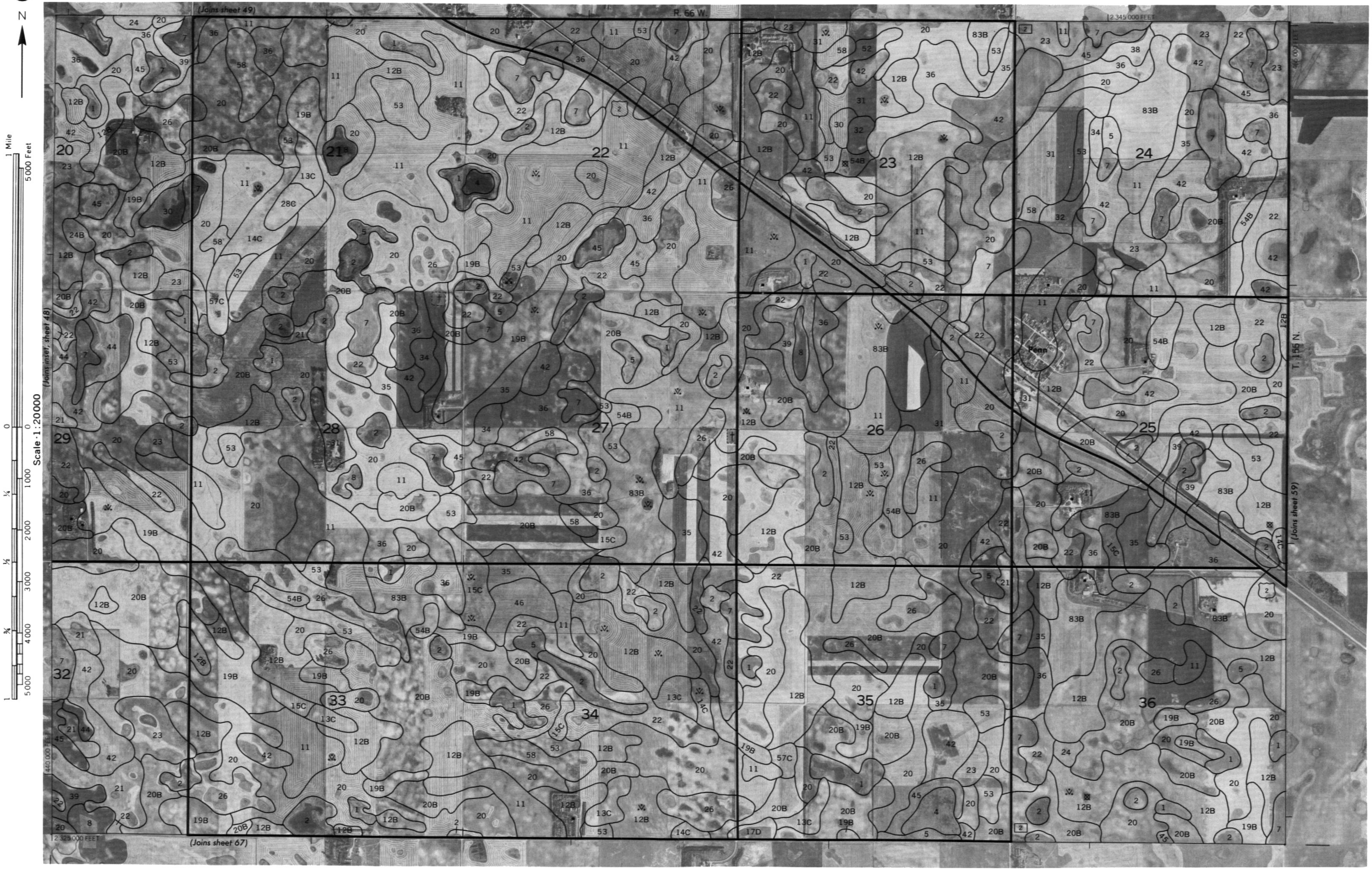
RAMSEY COUNTY, NORTH DAKOTA NO. 56

RAMSEY COUNTY, NORTH DAKOTA NO. 57

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

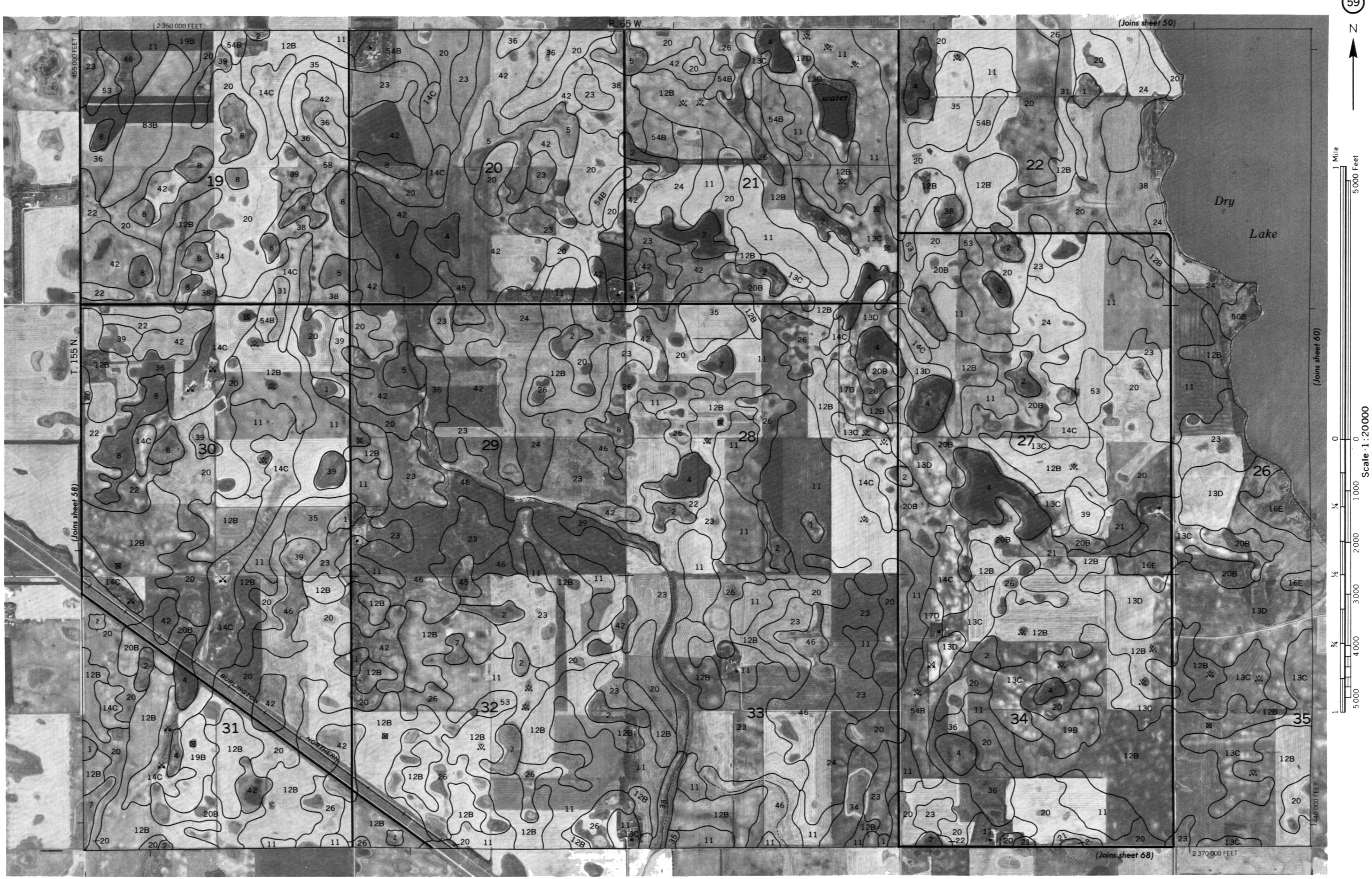


RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 58



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 58



RAMSEY COUNTY, NORTH DAKOTA NO. 59

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

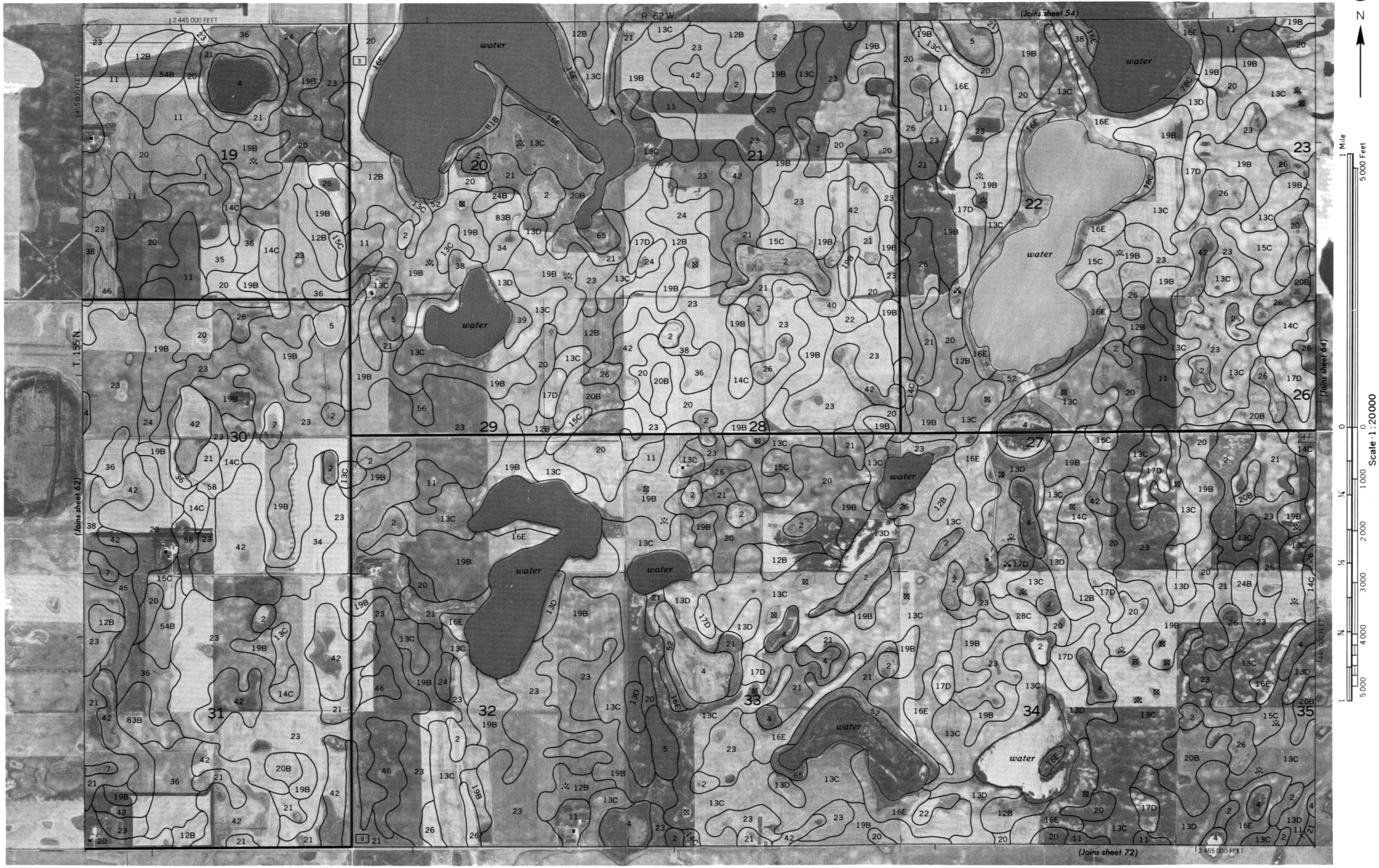
RAMSEY COUNTY, NORTH DAKOTA NO. 60

61

RAMSEY COUNTY, NORTH DAKOTA NO. 61

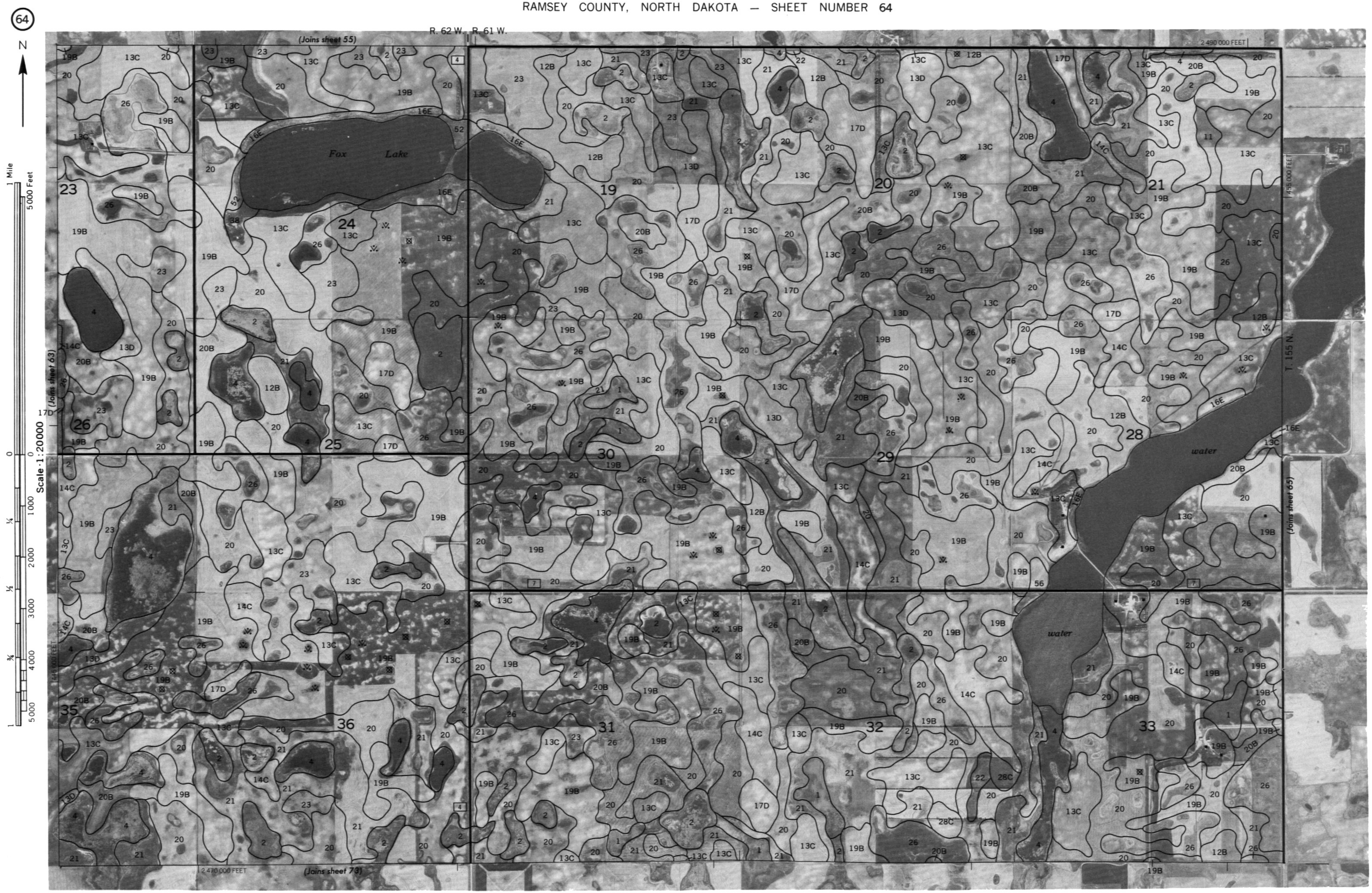
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



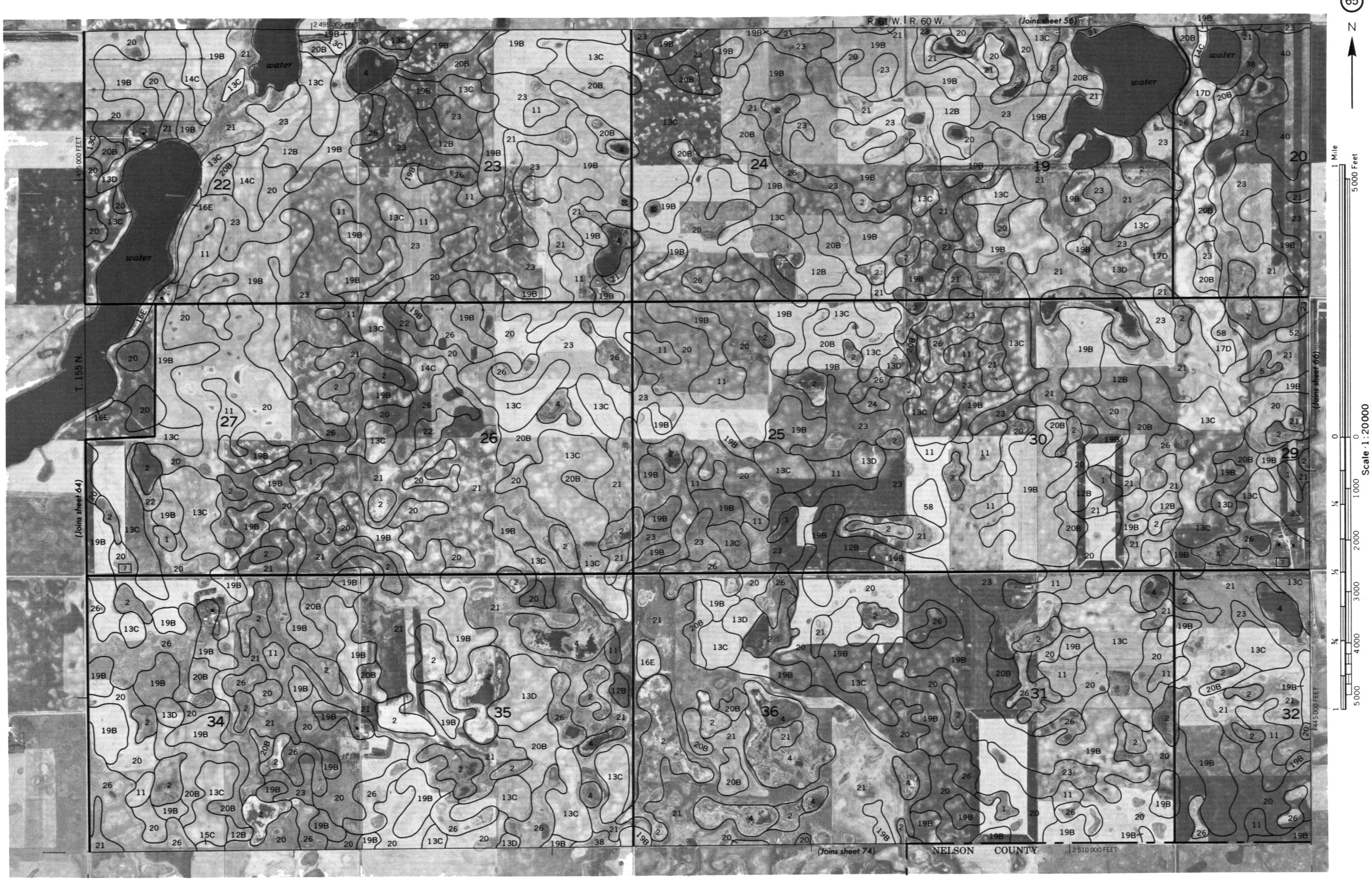
RAMSEY COUNTY, NORTH DAKOTA NO. 63

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

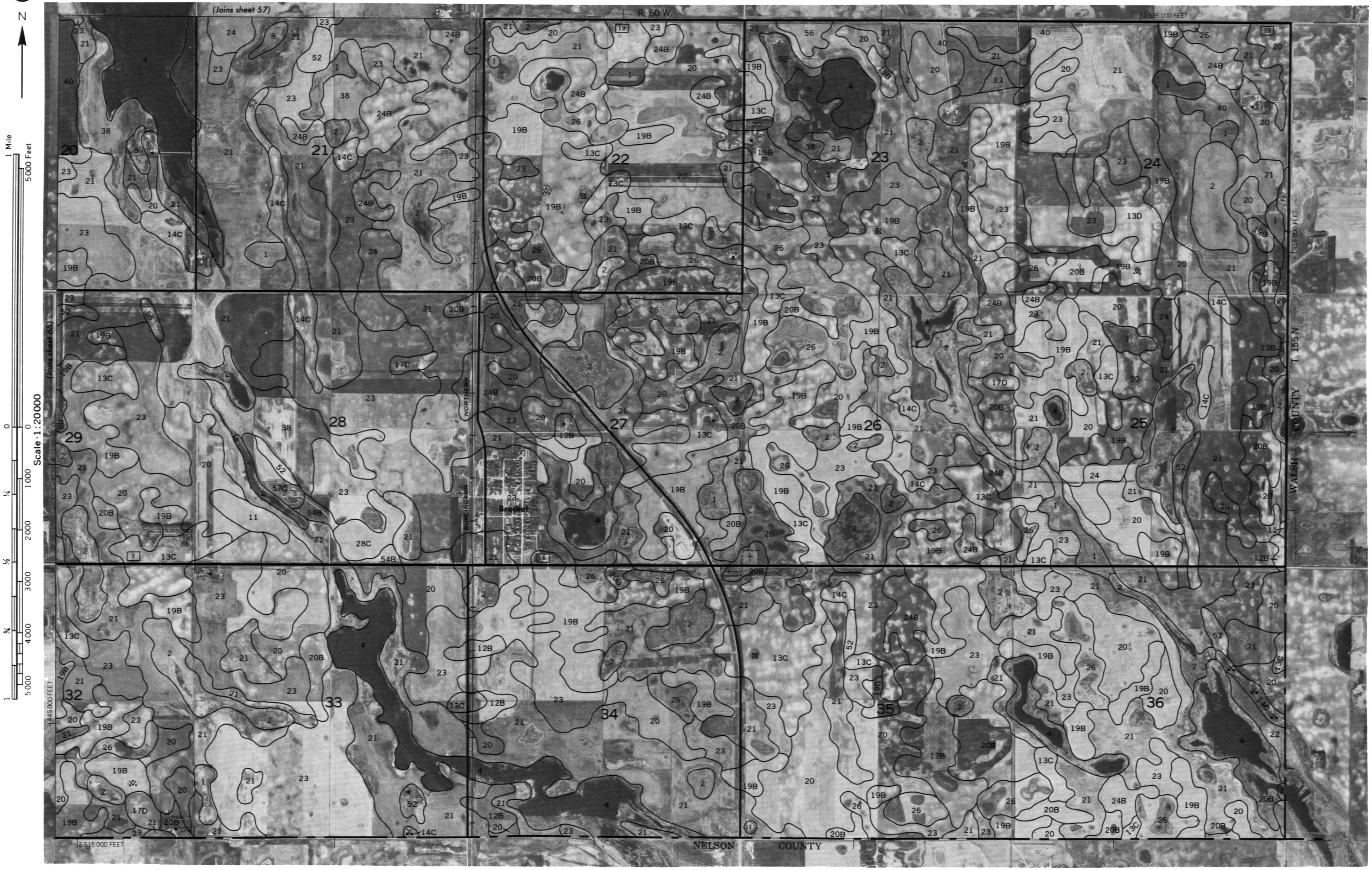
RAMSEY COUNTY, NORTH DAKOTA NO. 64



RAMSEY COUNTY, NORTH DAKOTA NO. 65

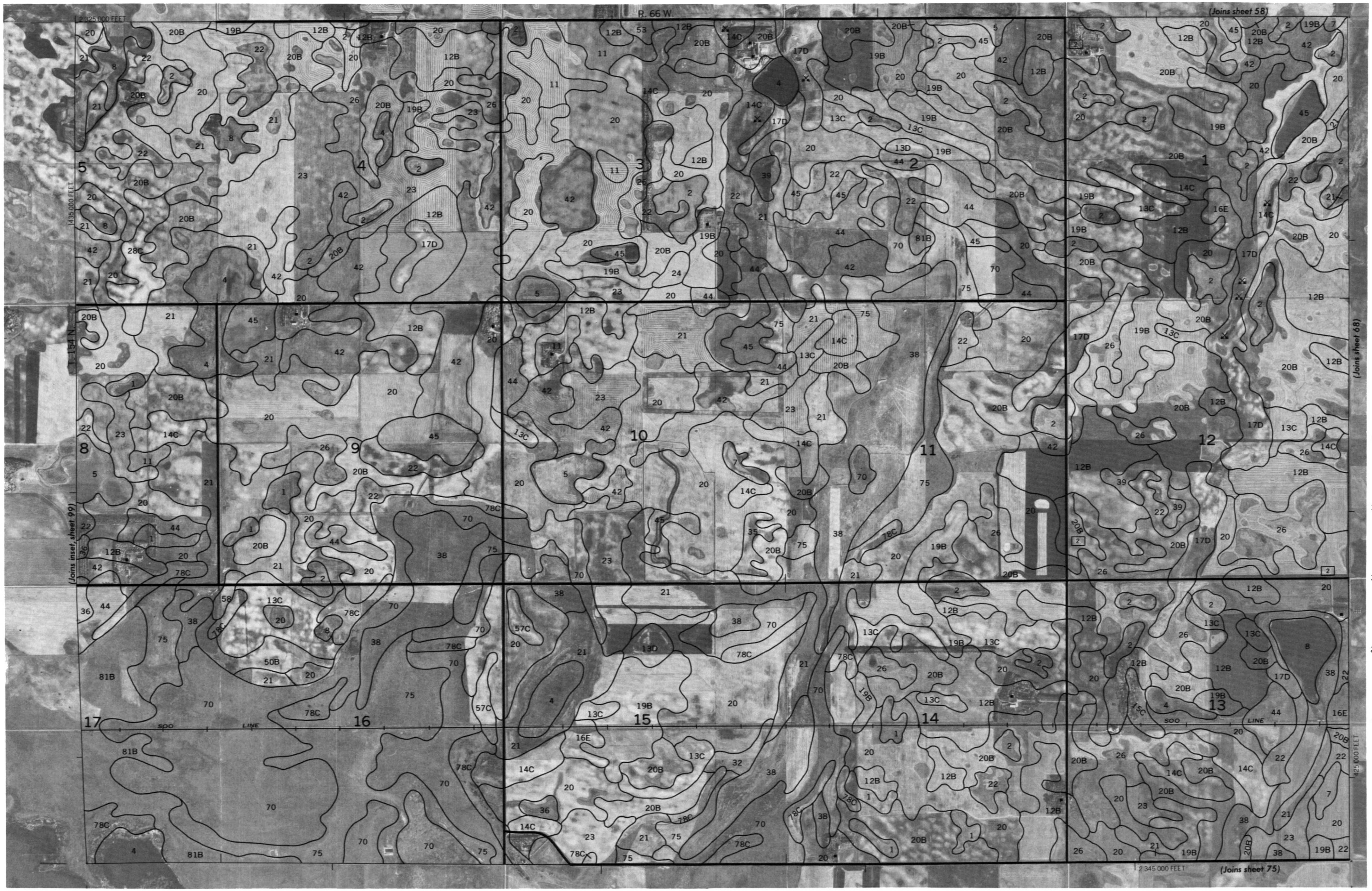
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 66



RAMSEY COUNTY, NORTH DAKOTA NO. 66

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

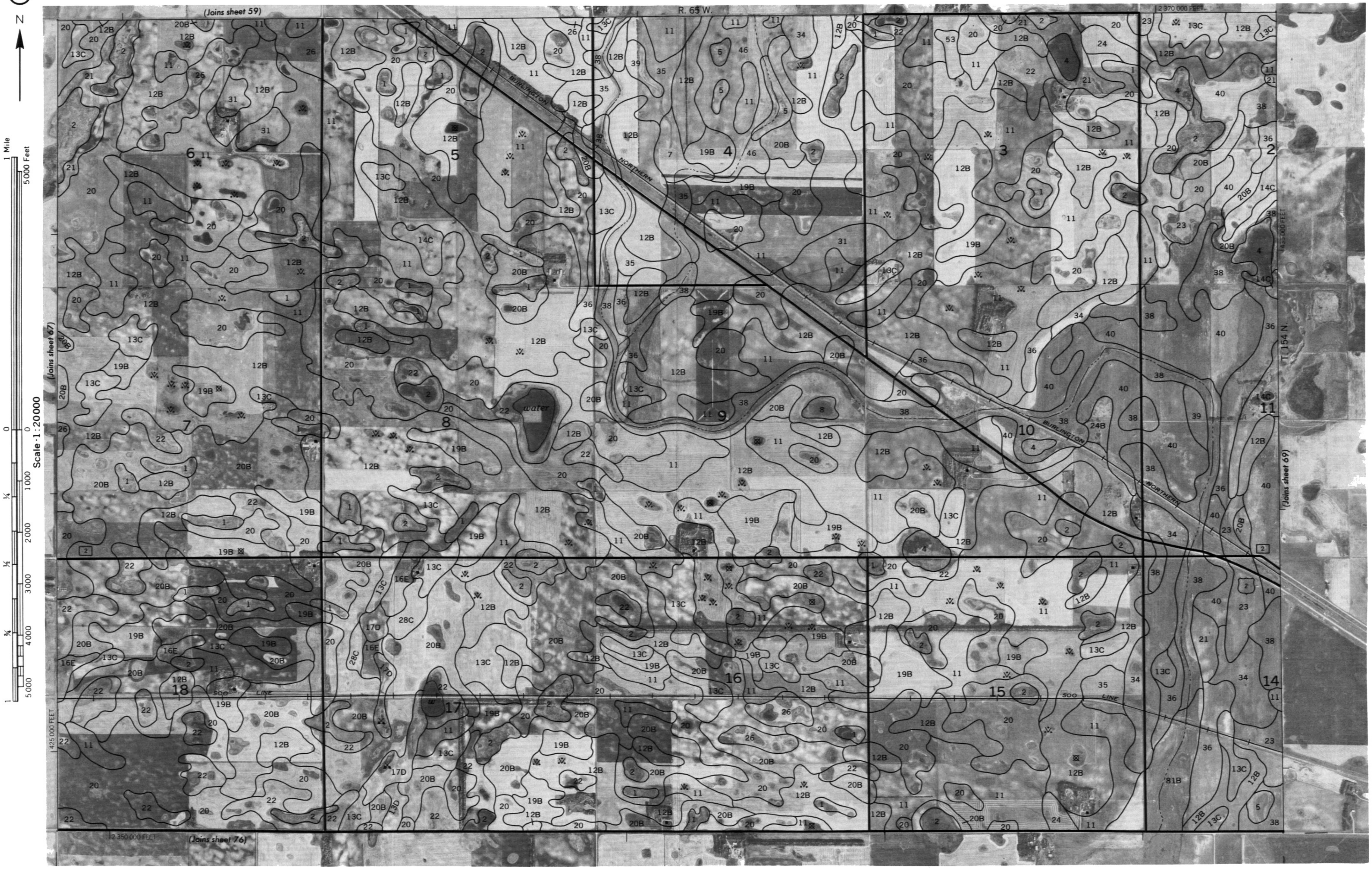
1 Mile

5000 Feet

Scale 1:20000

RAMSEY COUNTY, NORTH DAKOTA NO. 67

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



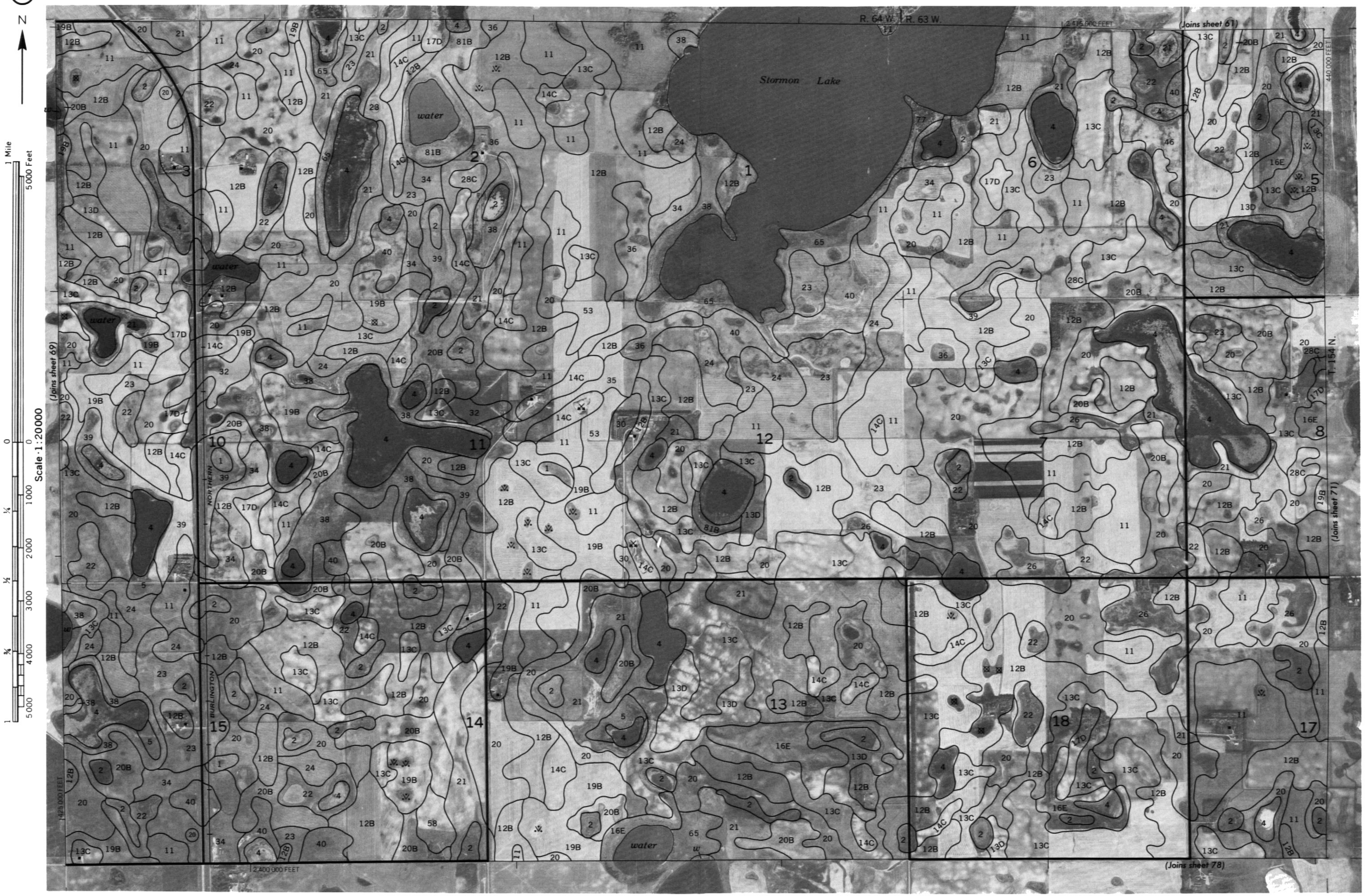
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 68

69

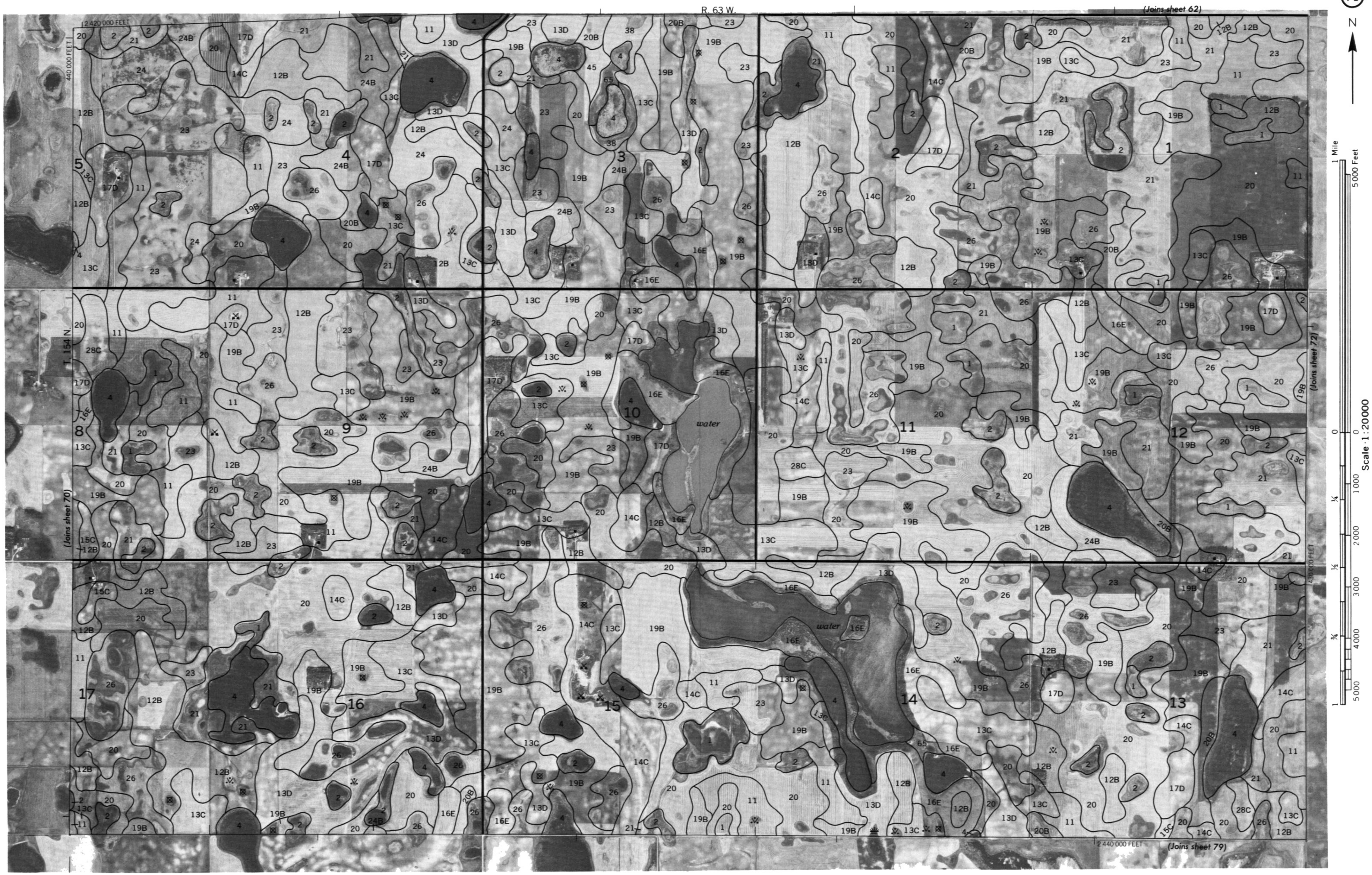
RAMSEY COUNTY, NORTH DAKOTA NO. 69

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

71



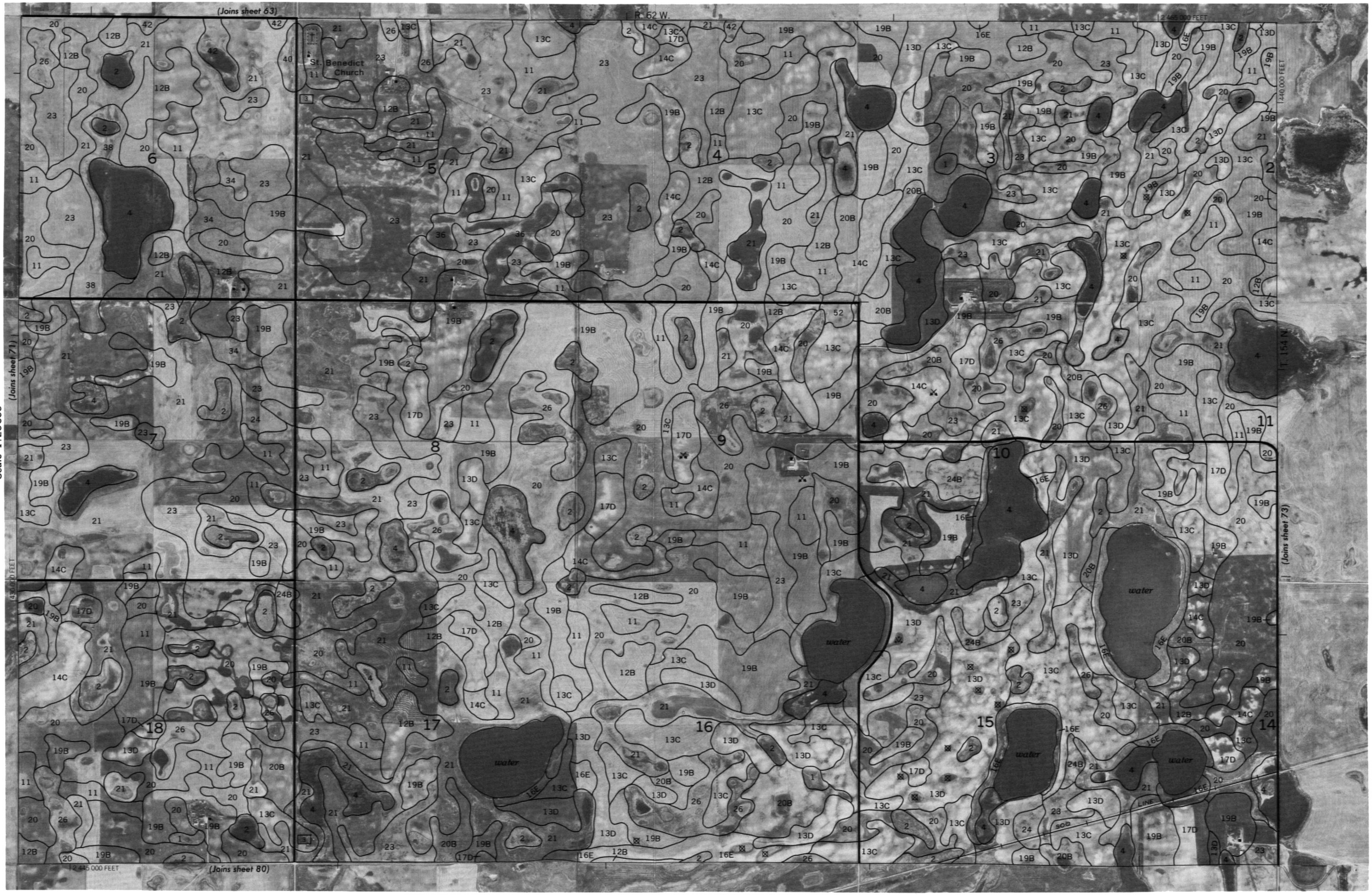
RAMSEY COUNTY, NORTH DAKOTA NO. 71

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 72

N

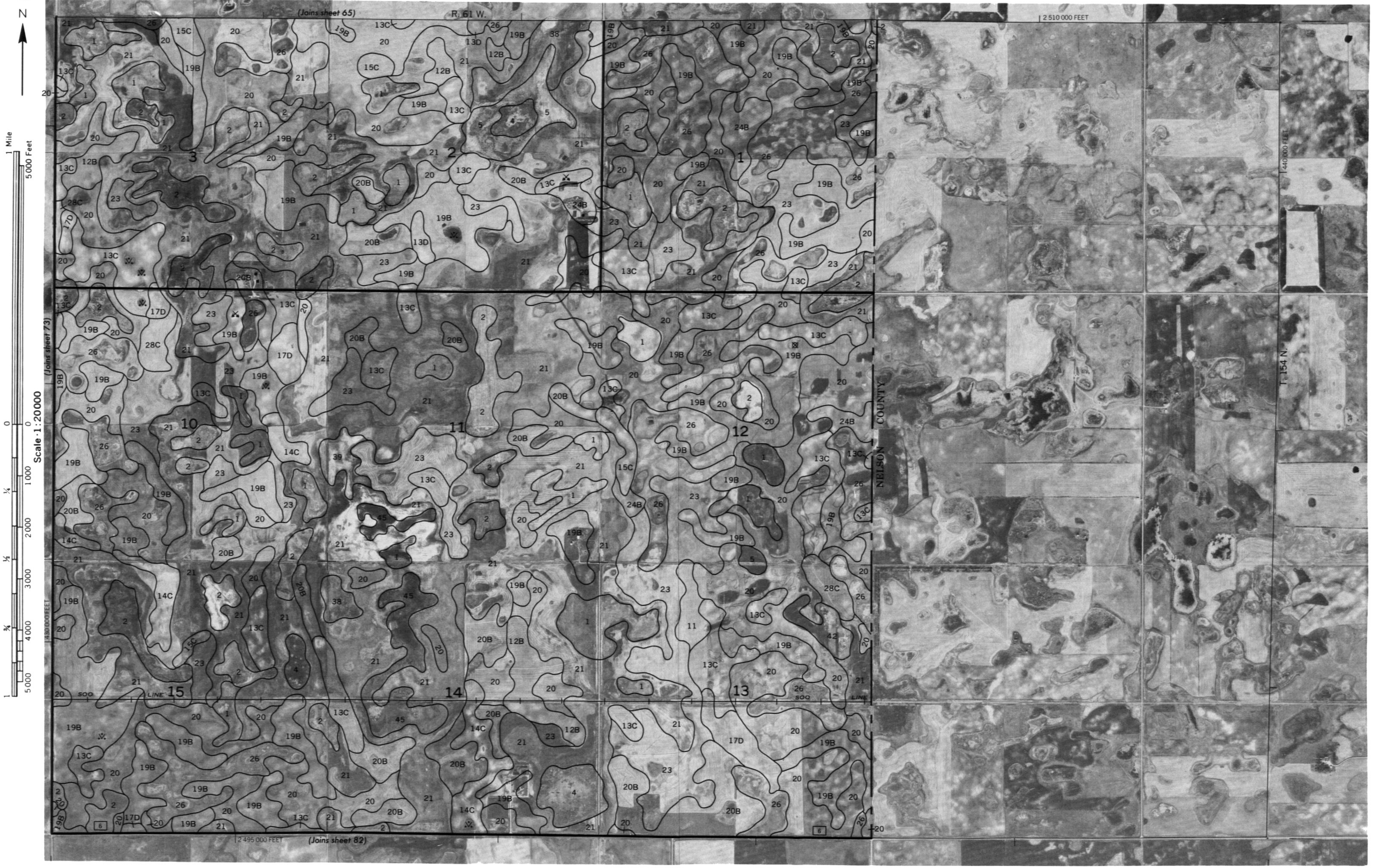
1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 73

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

RAMSEY COUNTY, NORTH DAKOTA NO. 75

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

N

1 Mile

5000 Feet

0

¼

½

¾

1

0 1000 2000 3000 4000 5000

Scale 1:20000

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 76

77

RAMSEY COUNTY, NORTH DAKOTA NO. 77

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 78

N

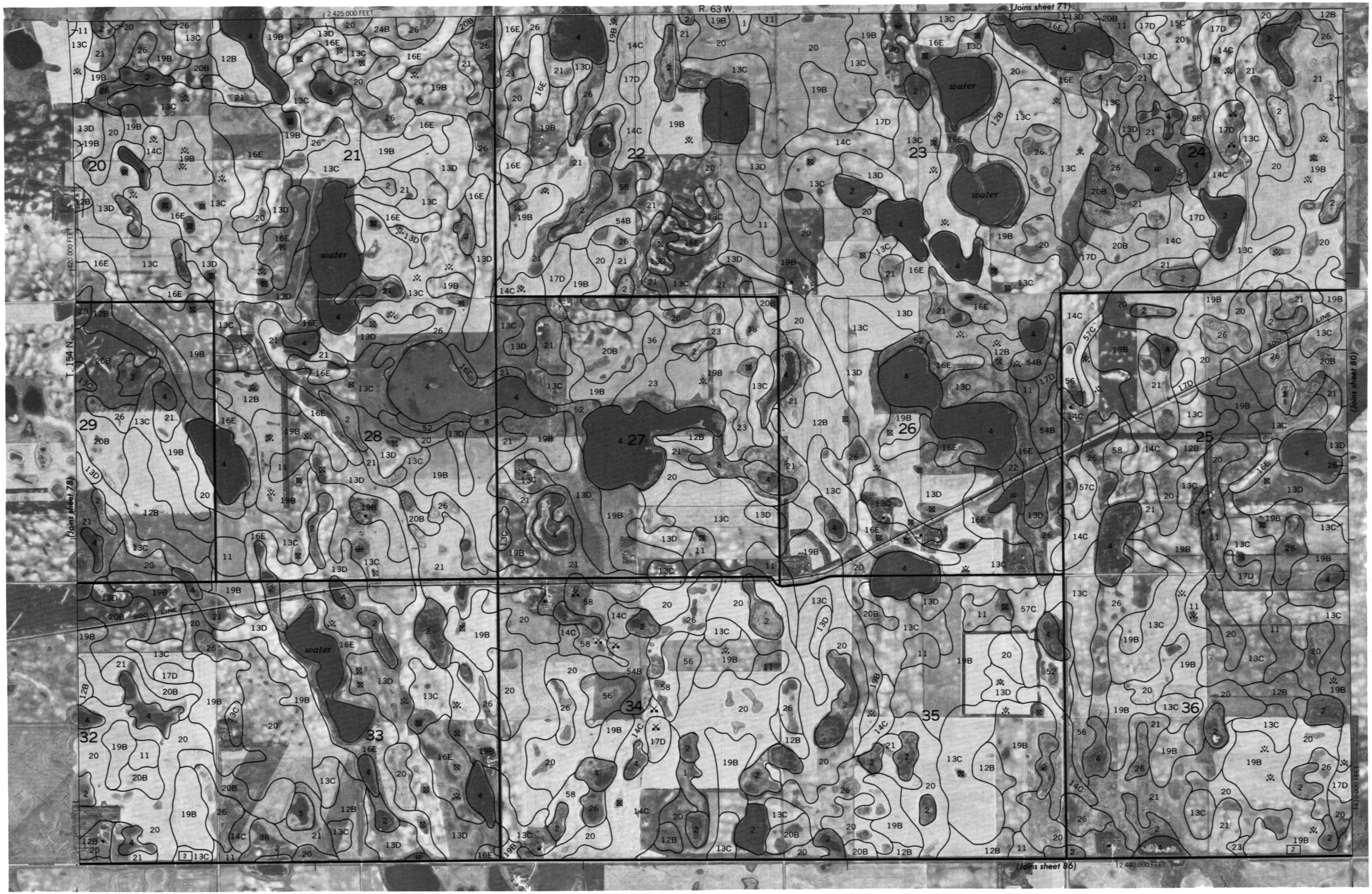
1 Mile
5000 Feet

Scale 1:20000

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 78

N

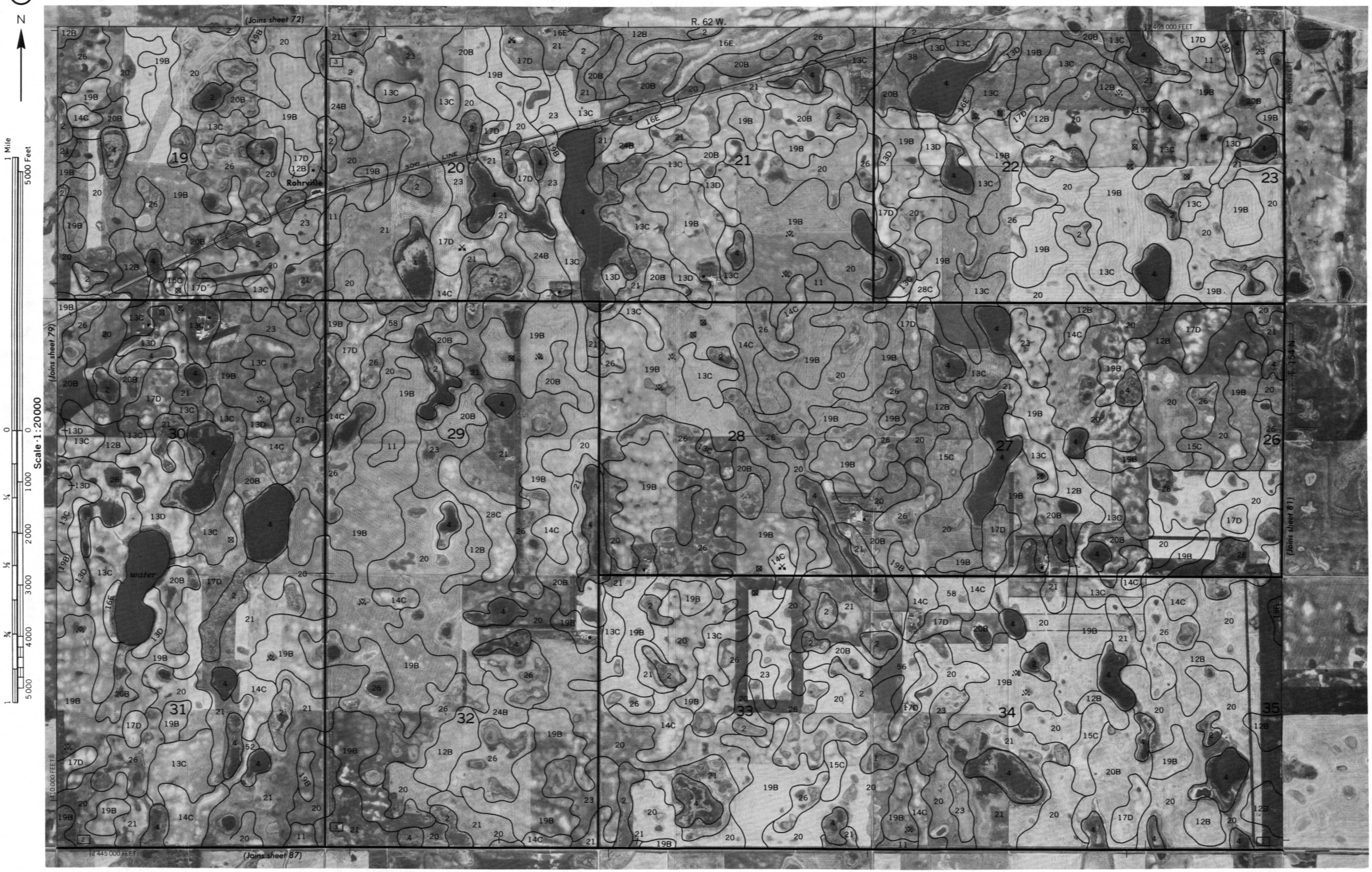


1 Mile
5000 Feet
Scale 1:20000
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000

RAMSEY COUNTY, NORTH DAKOTA NO. 79

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

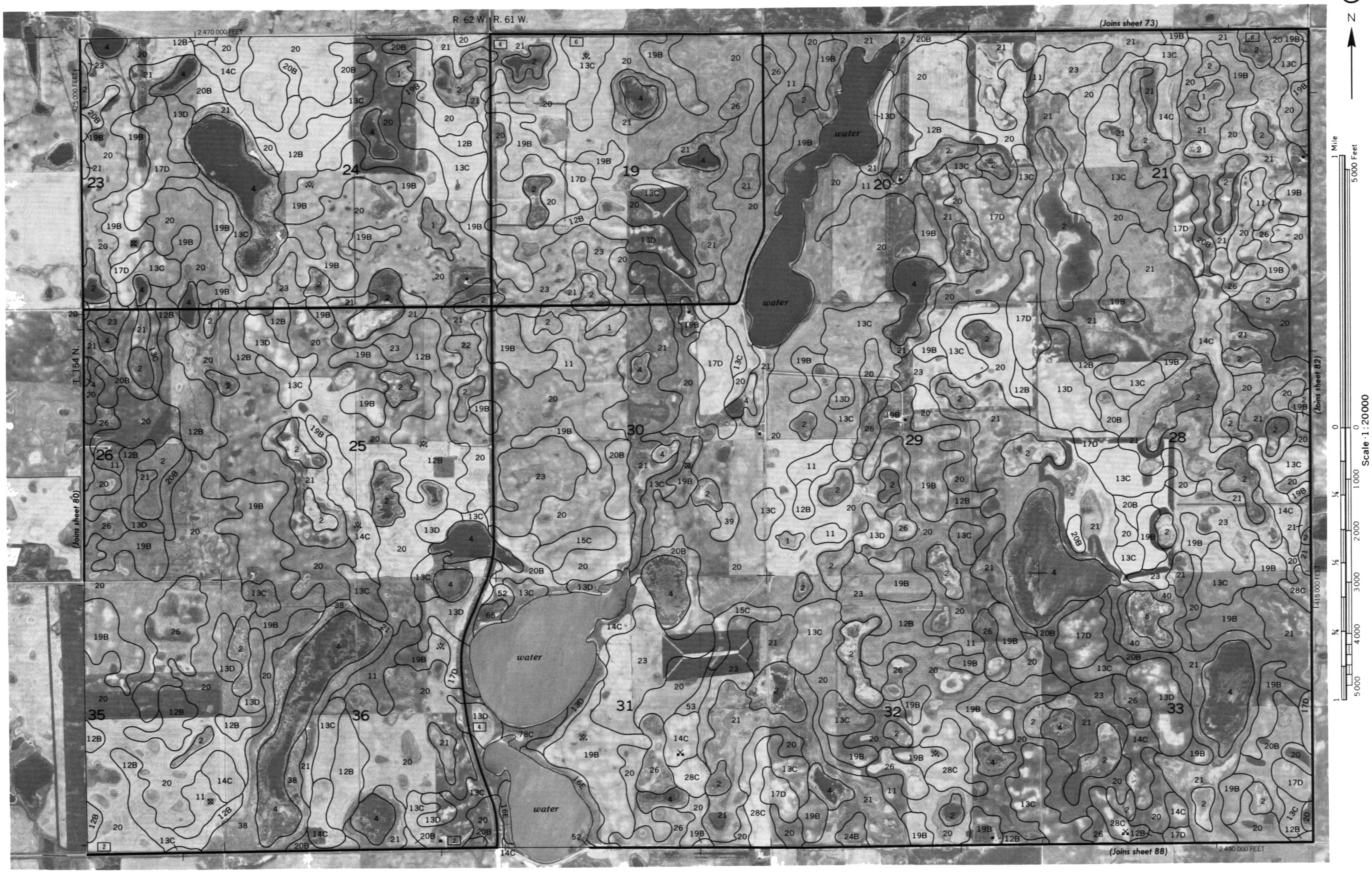
RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 80



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 80

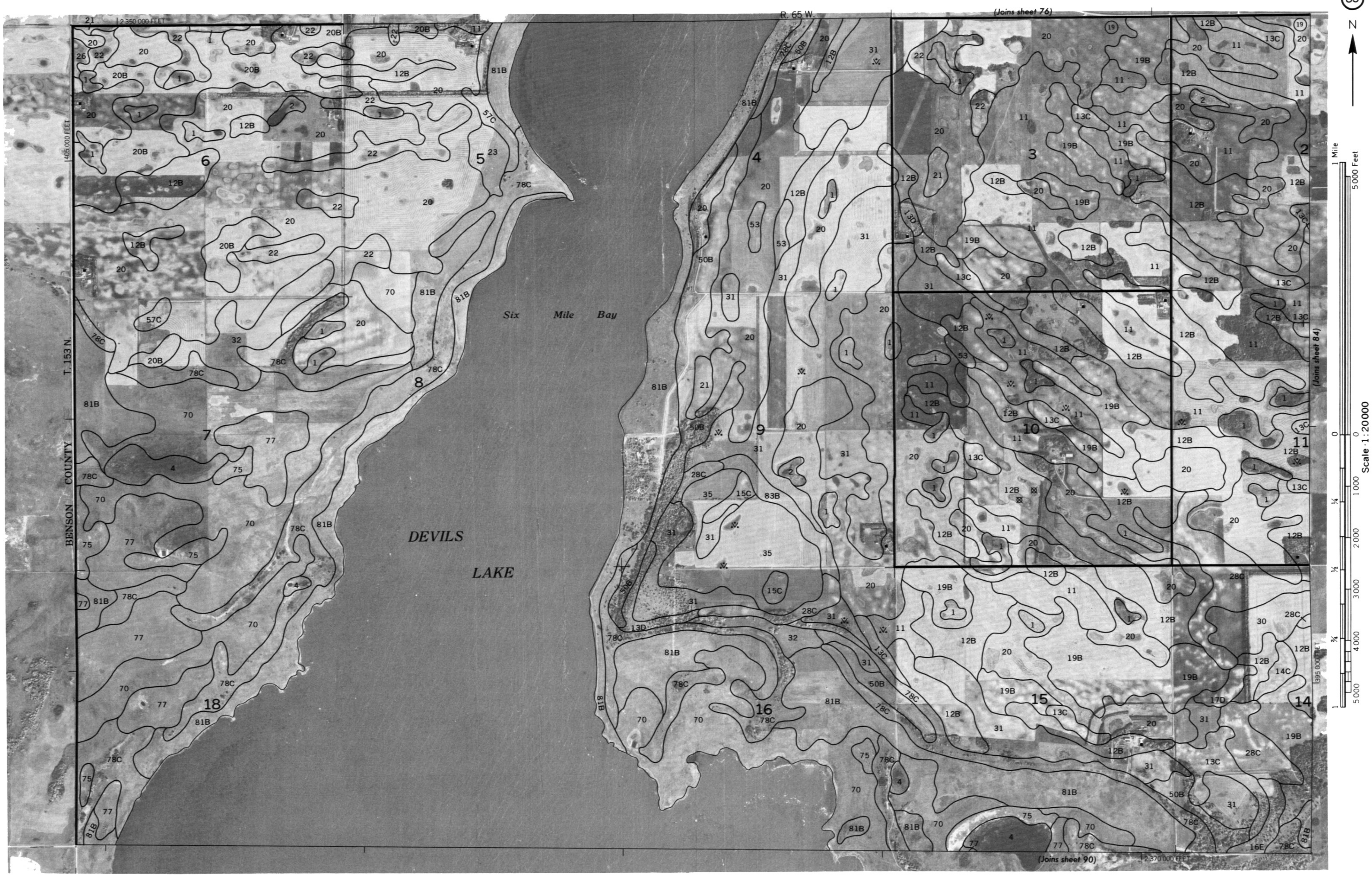
81



RAMSEY COUNTY, NORTH DAKOTA NO. 81

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



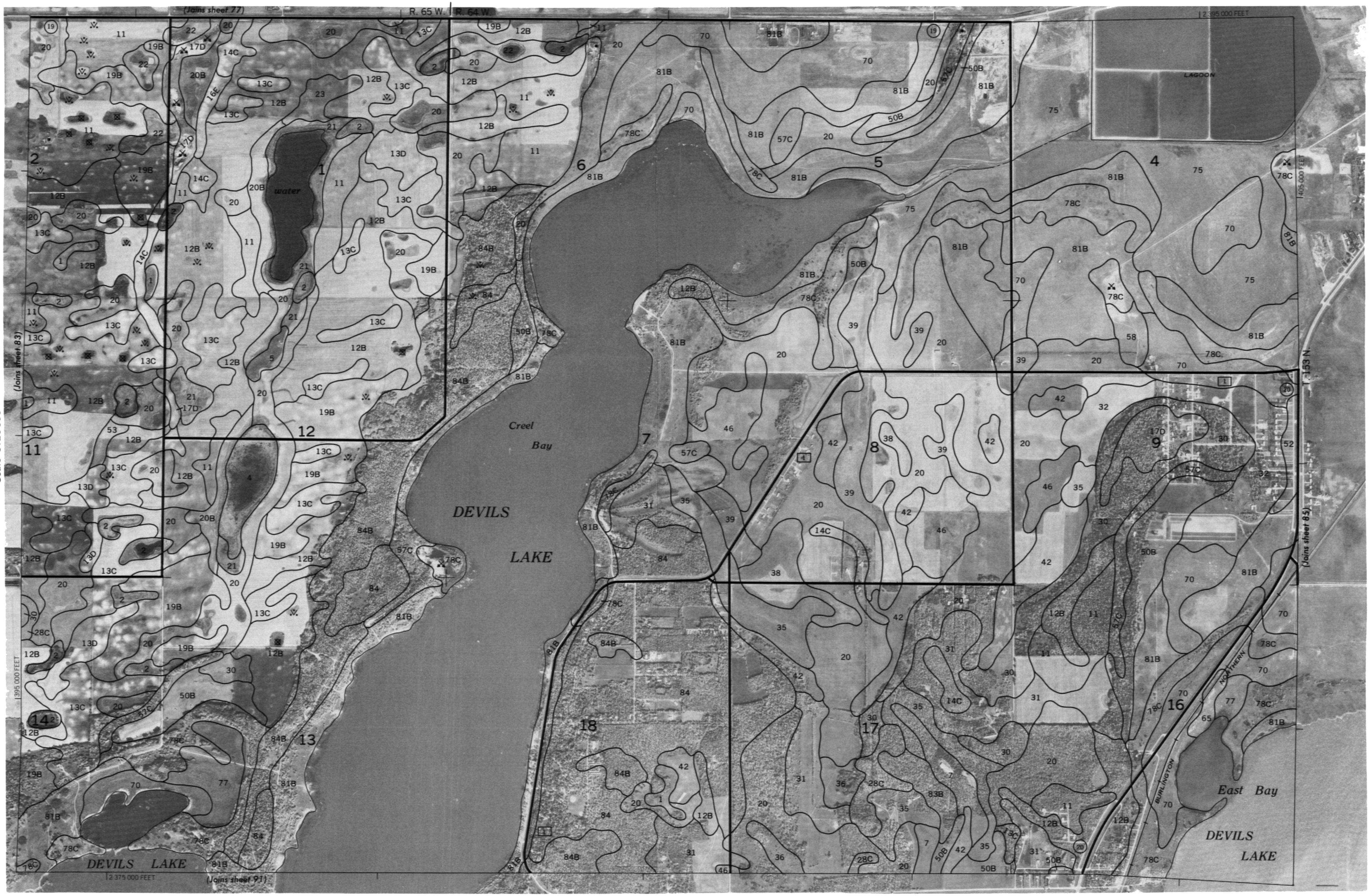
RAMSEY COUNTY, NORTH DAKOTA NO. 83

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

84

N

1 Mile
5000 Feet
Scale 1:20000



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 84

RAMSEY COUNTY, NORTH DAKOTA NO. 85

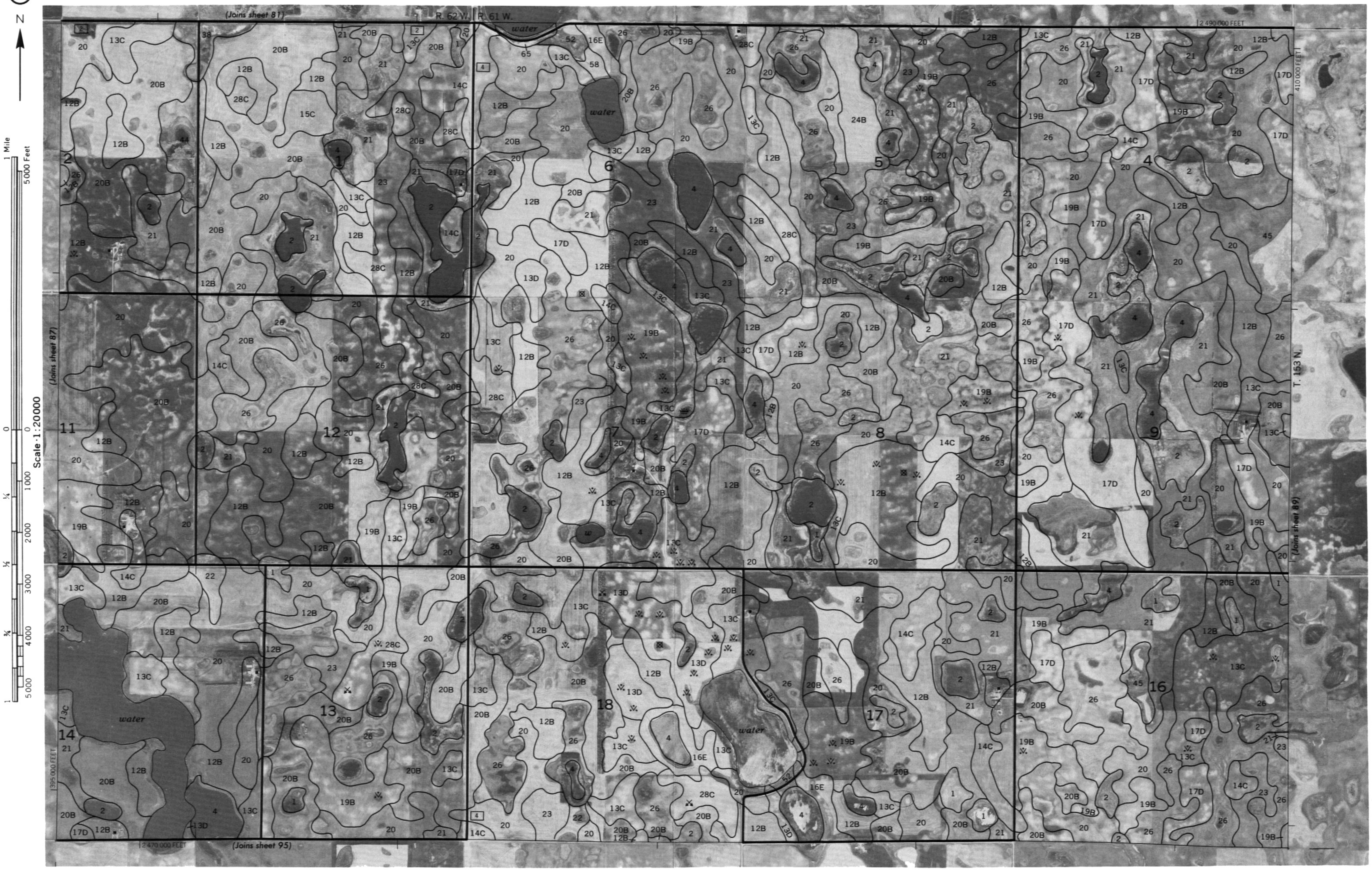
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

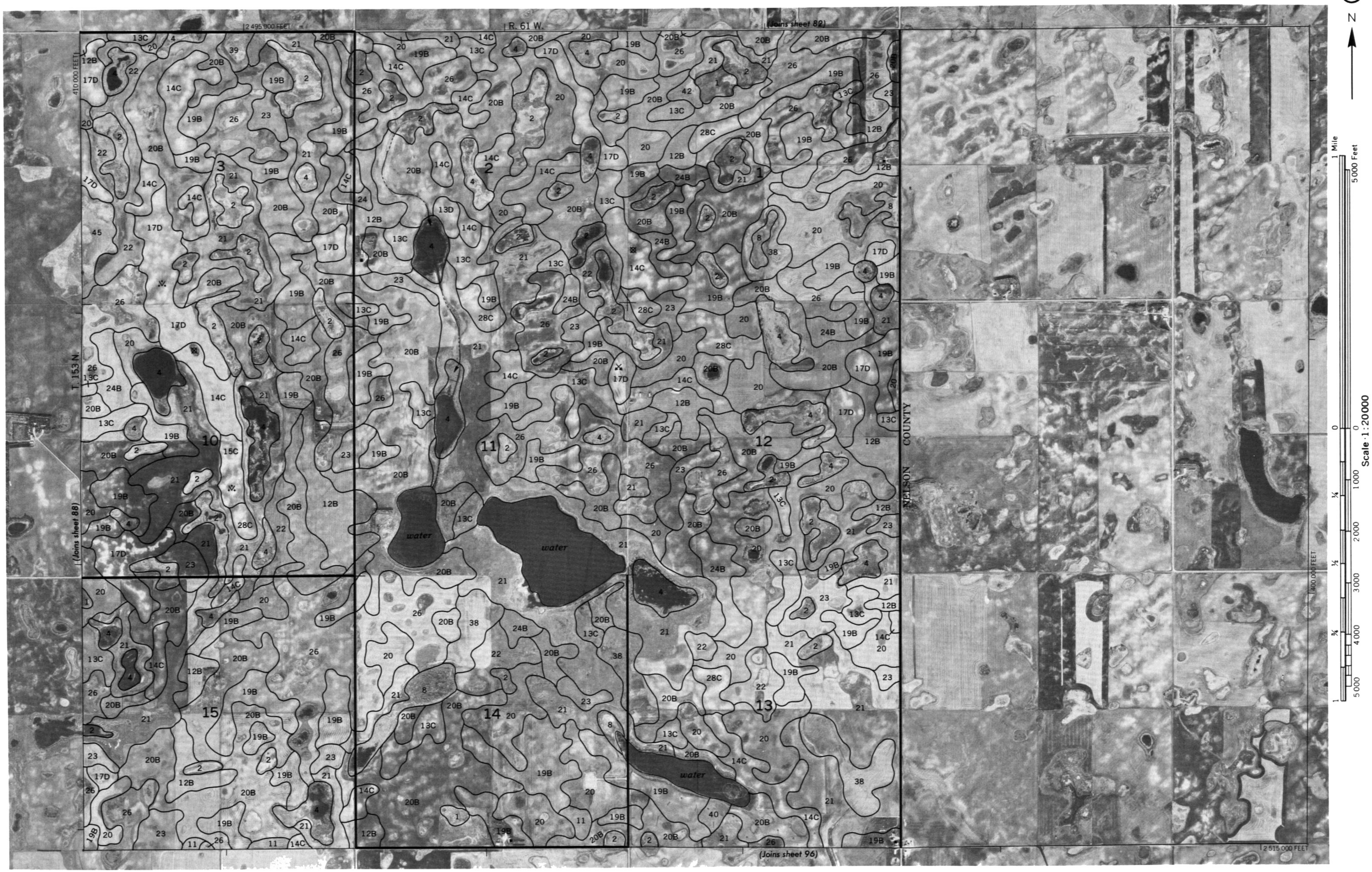
RAMSEY COUNTY, NORTH DAKOTA NO. 86

RAMSEY COUNTY, NORTH DAKOTA NO. 87

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

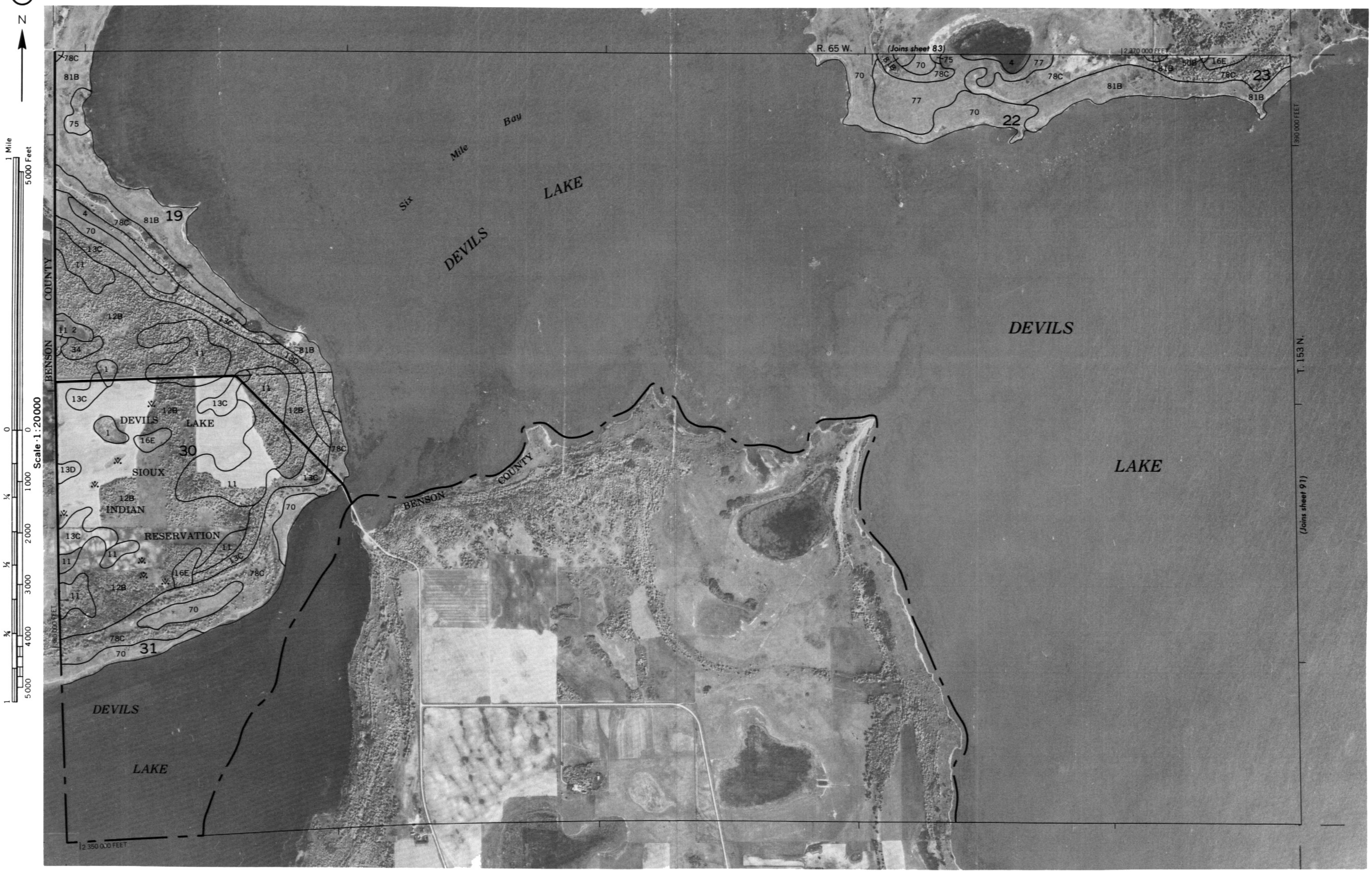


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

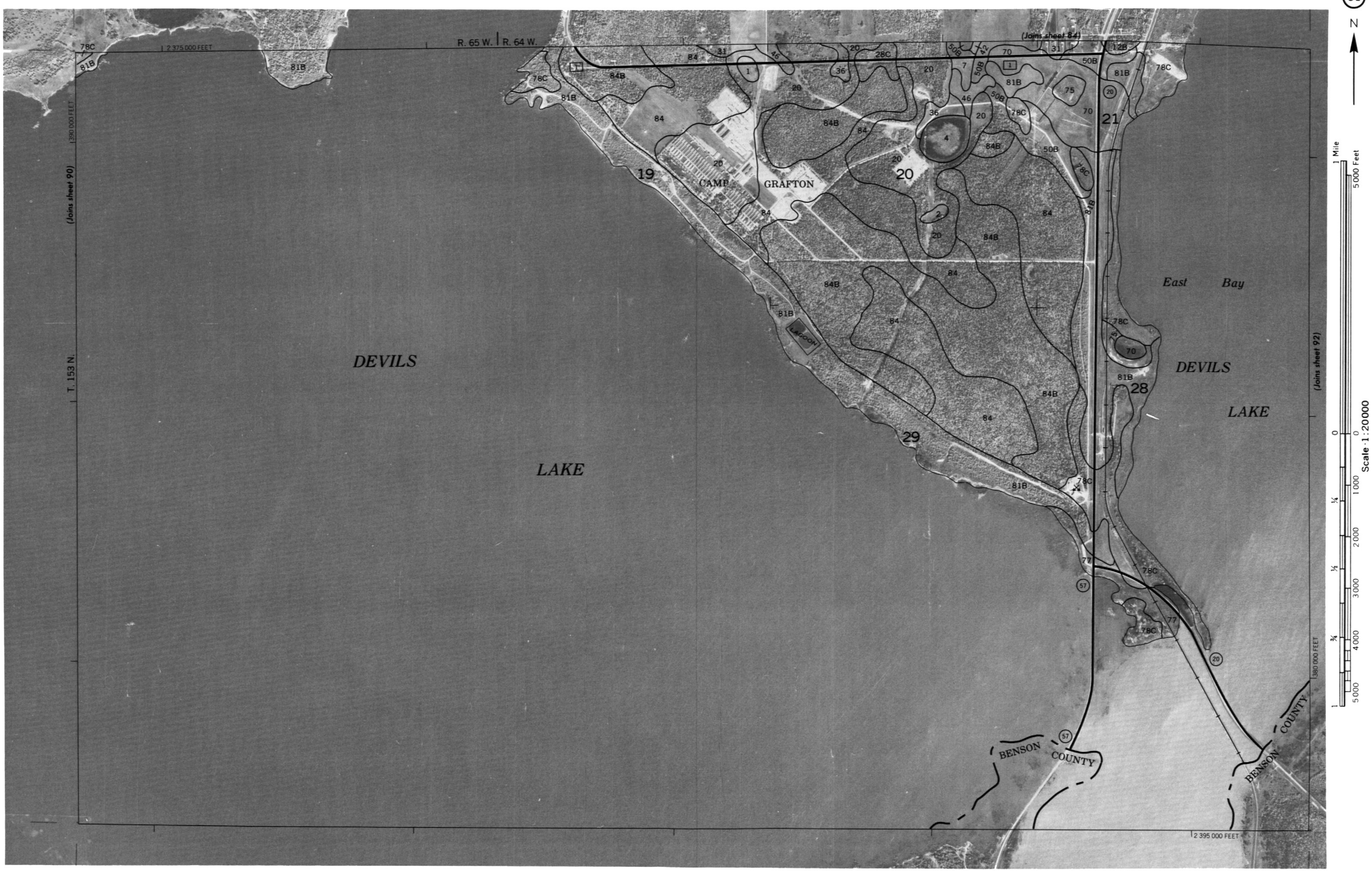


RAMSEY COUNTY, NORTH DAKOTA NO. 89

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



RAMSEY COUNTY, NORTH DAKOTA NO. 91

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 92

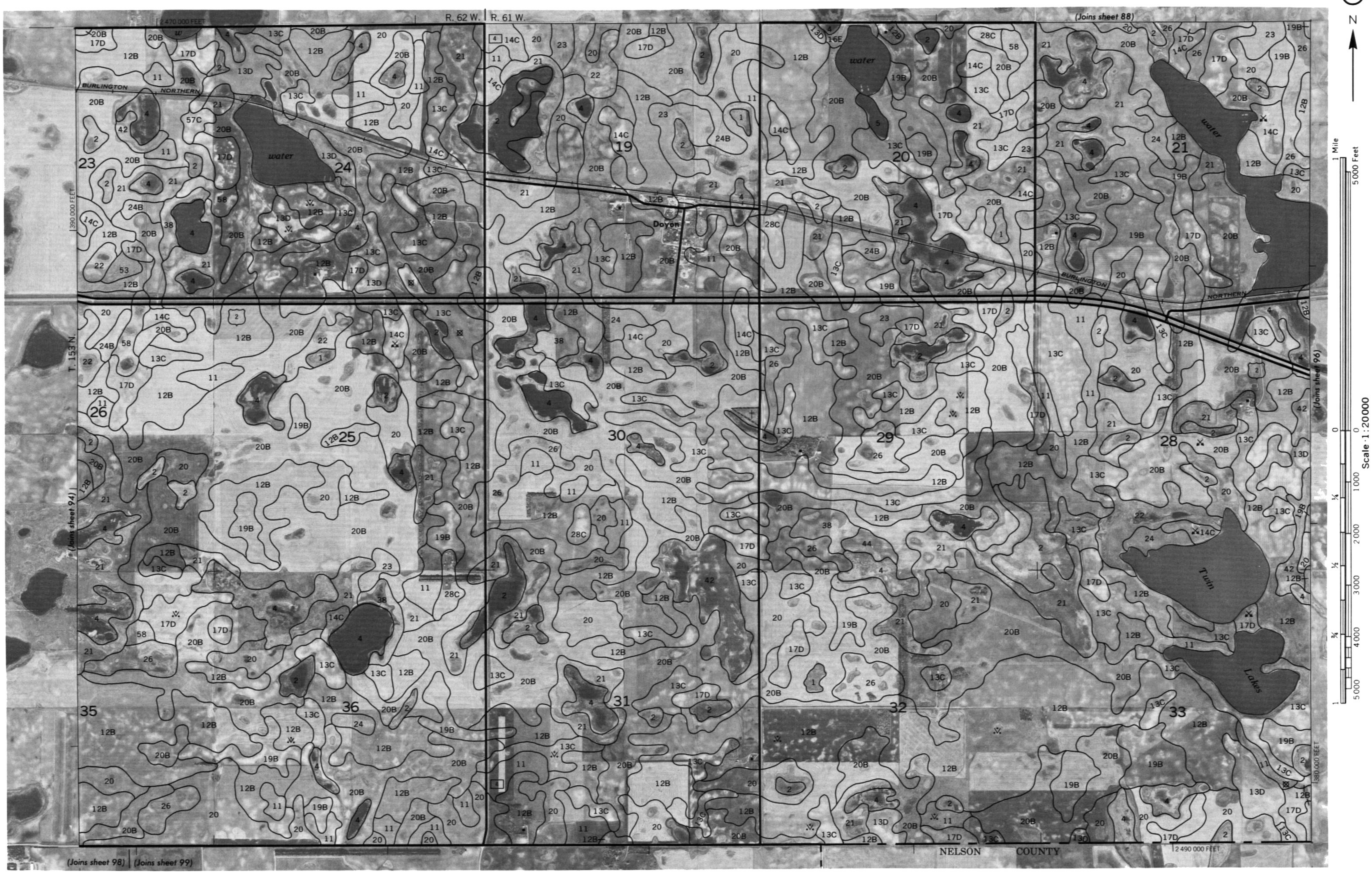
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 93

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

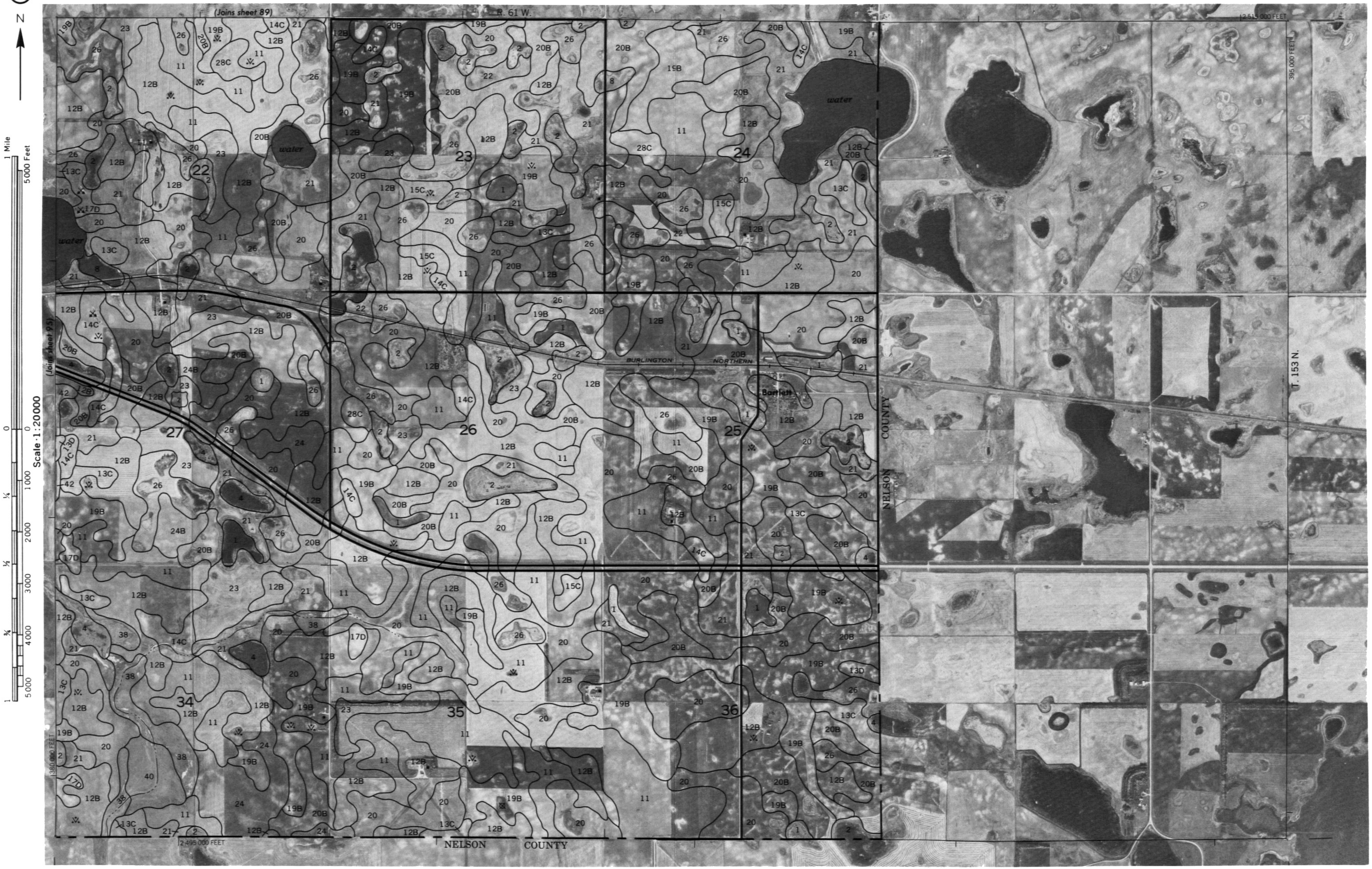
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 94



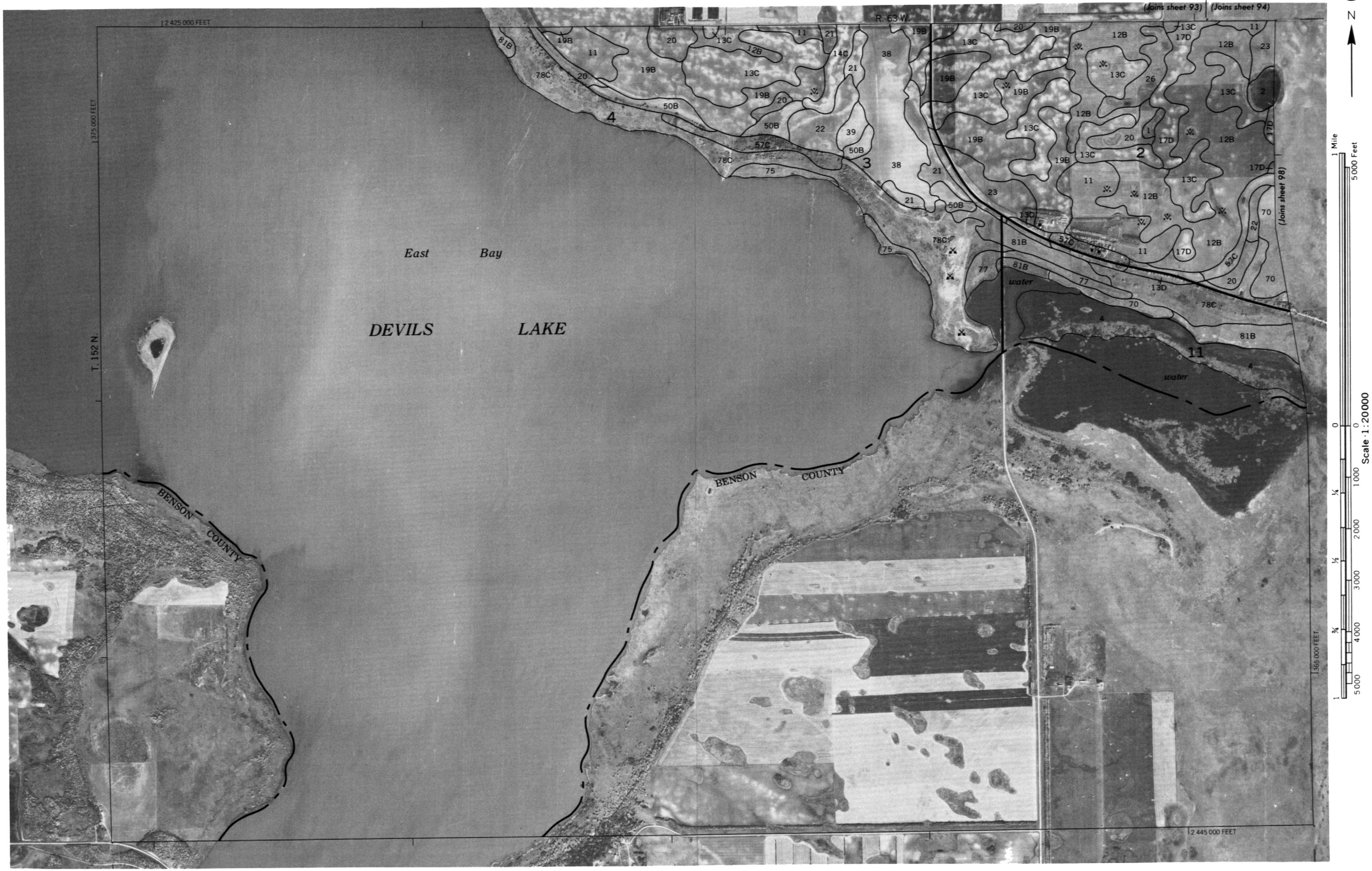
RAMSEY COUNTY, NORTH DAKOTA NO. 95

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 96



RAMSEY COUNTY, NORTH DAKOTA NO. 97

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

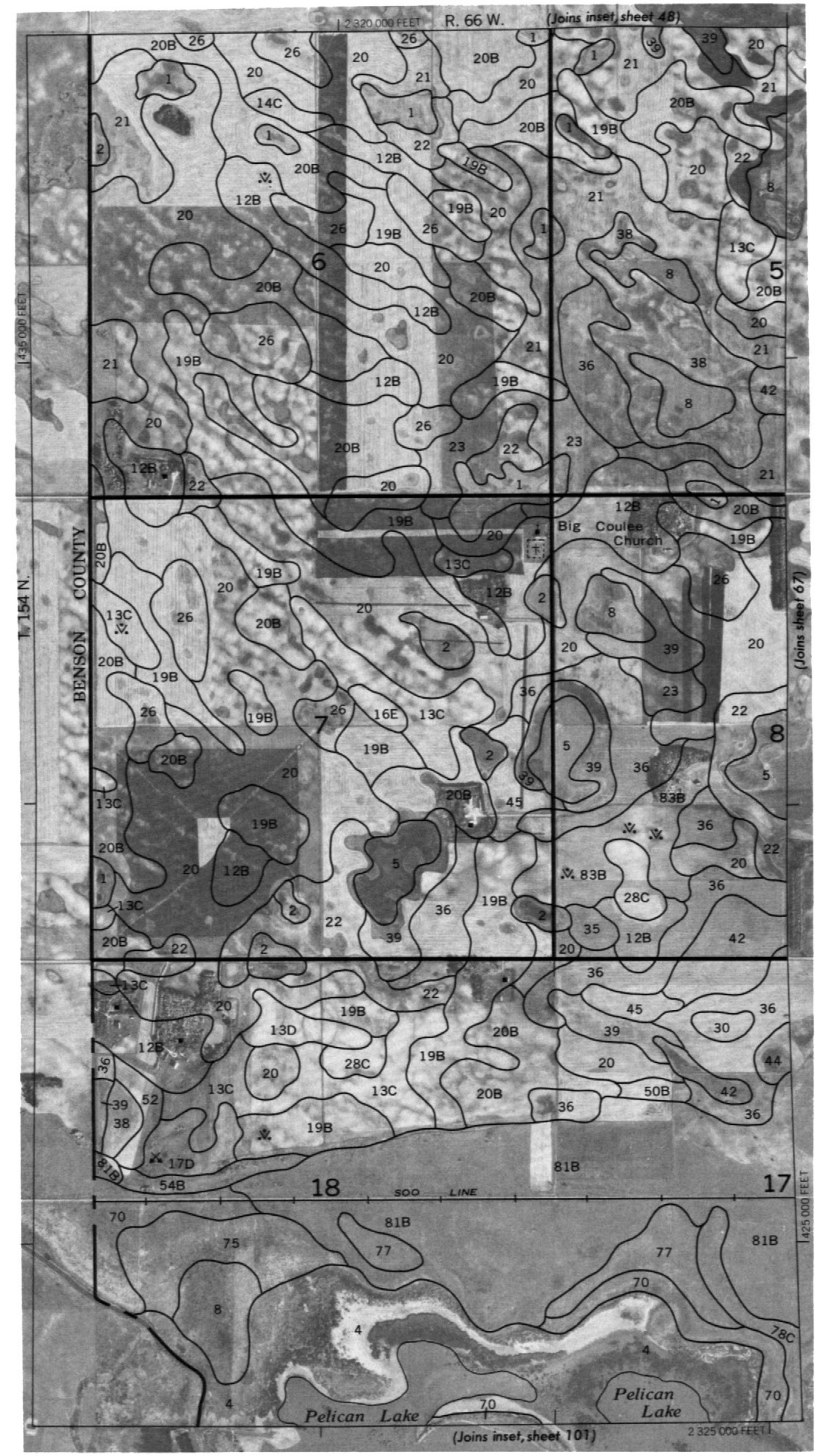
RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 98

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

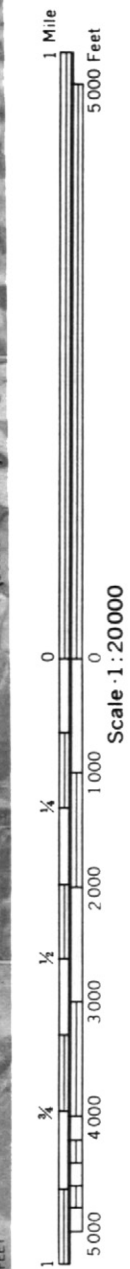
RAMSEY COUNTY, NORTH DAKOTA NO. 98

RAMSEY COUNTY, NORTH DAKOTA NO. 99

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N



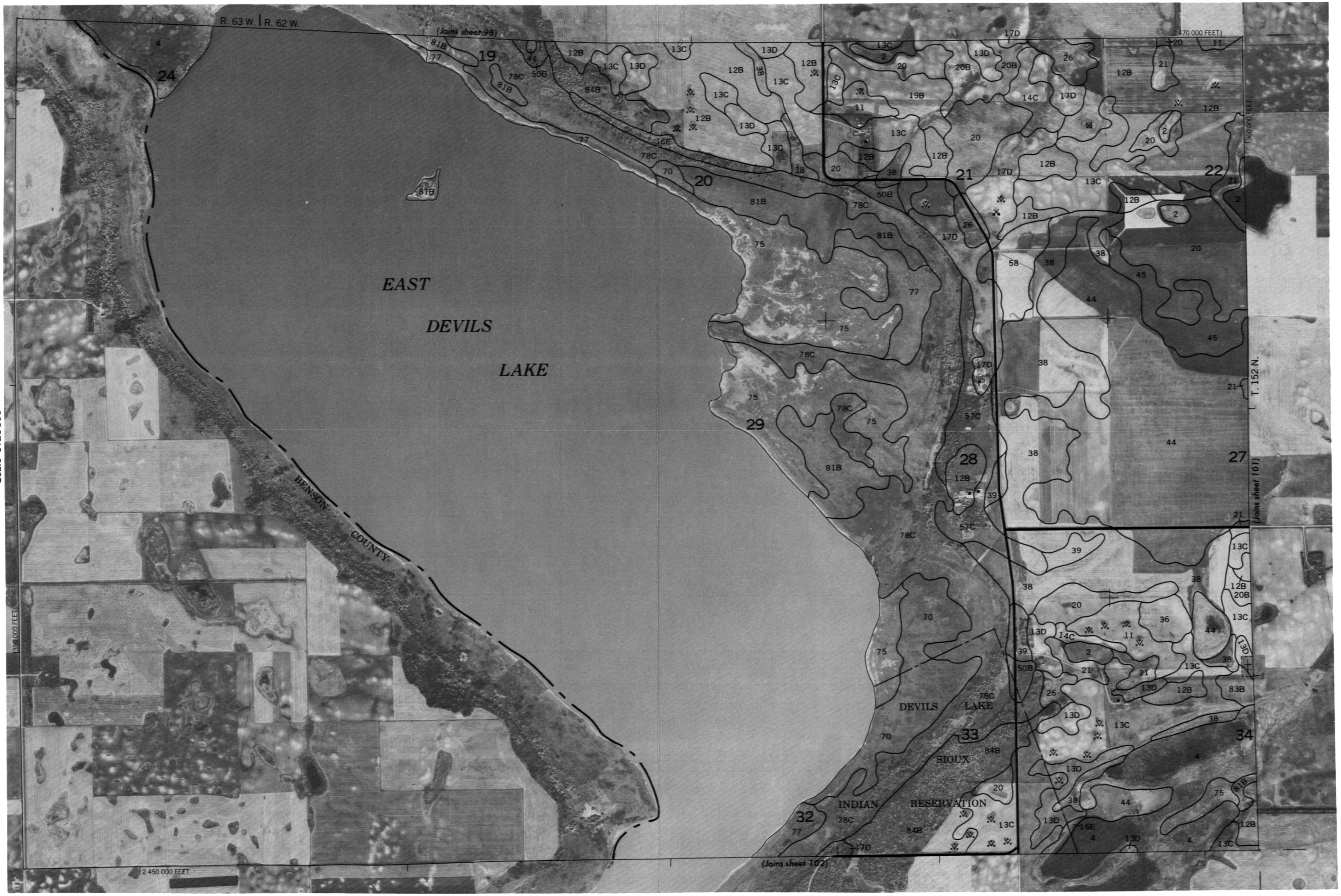
(100)

N

Scale 1:20000

1 Mile

5000 Feet



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

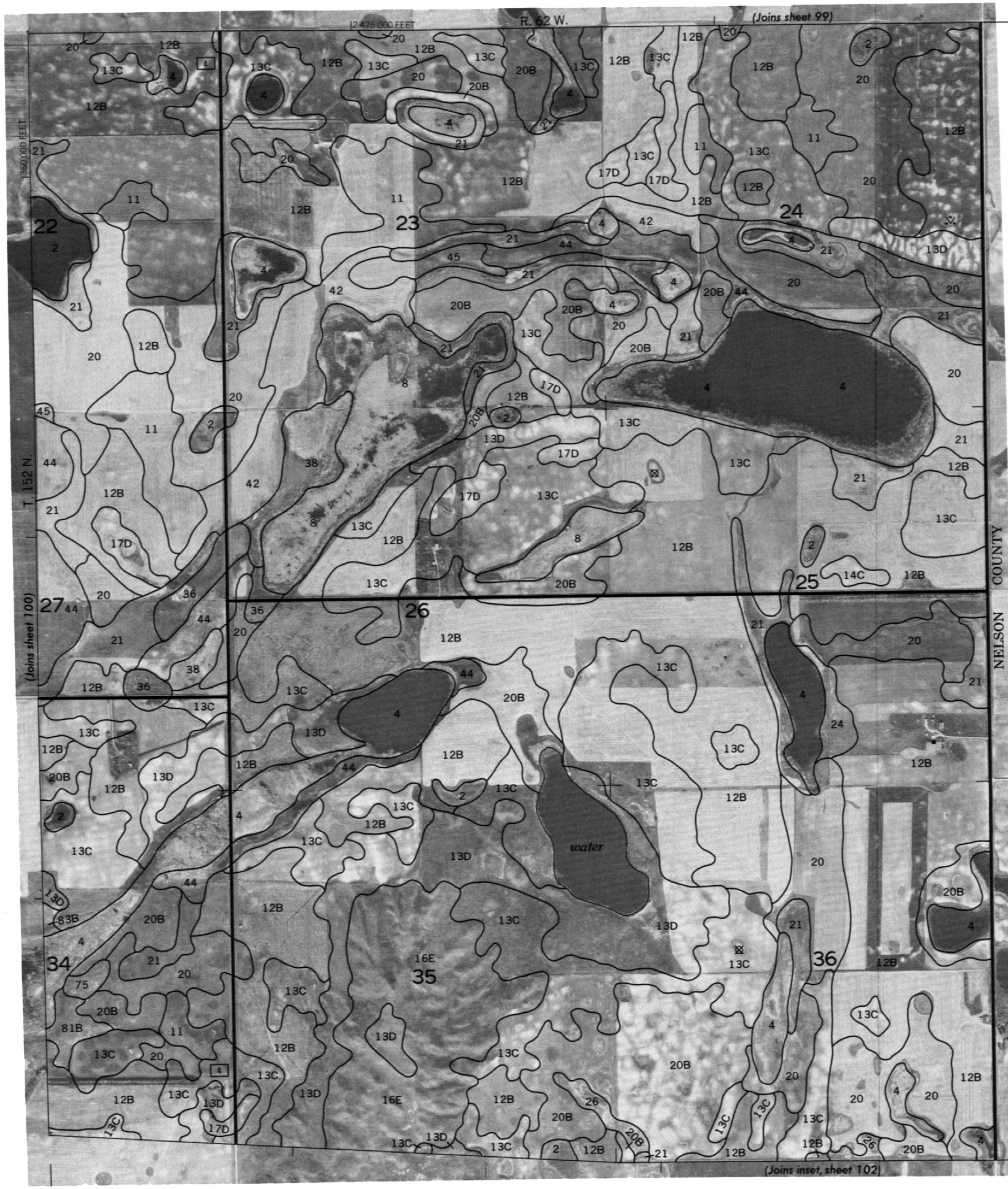
RAMSEY COUNTY, NORTH DAKOTA NO. 100

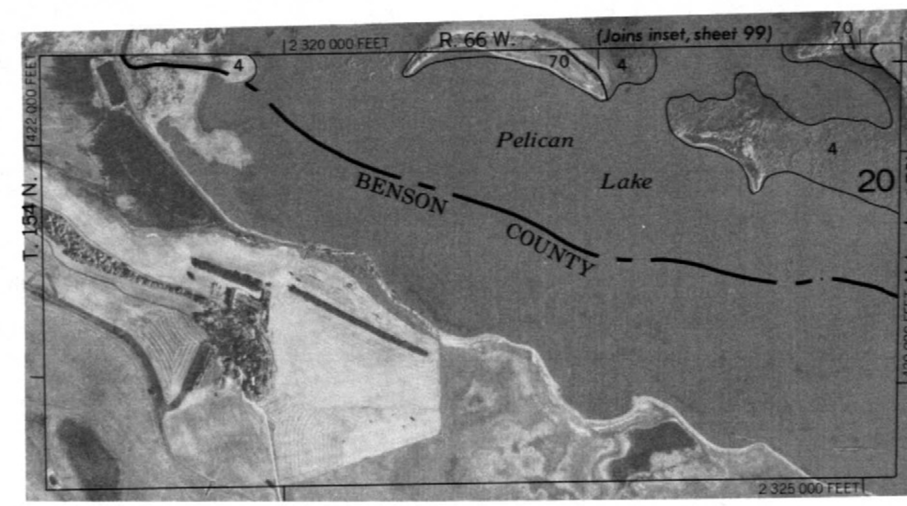
101

N

RAMSEY COUNTY, NORTH DAKOTA NO. 101

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.





2000 AND 5000-FOOT GRID TICKS

2 490 000 FEET

350 000 FEET

Scale 1:20000

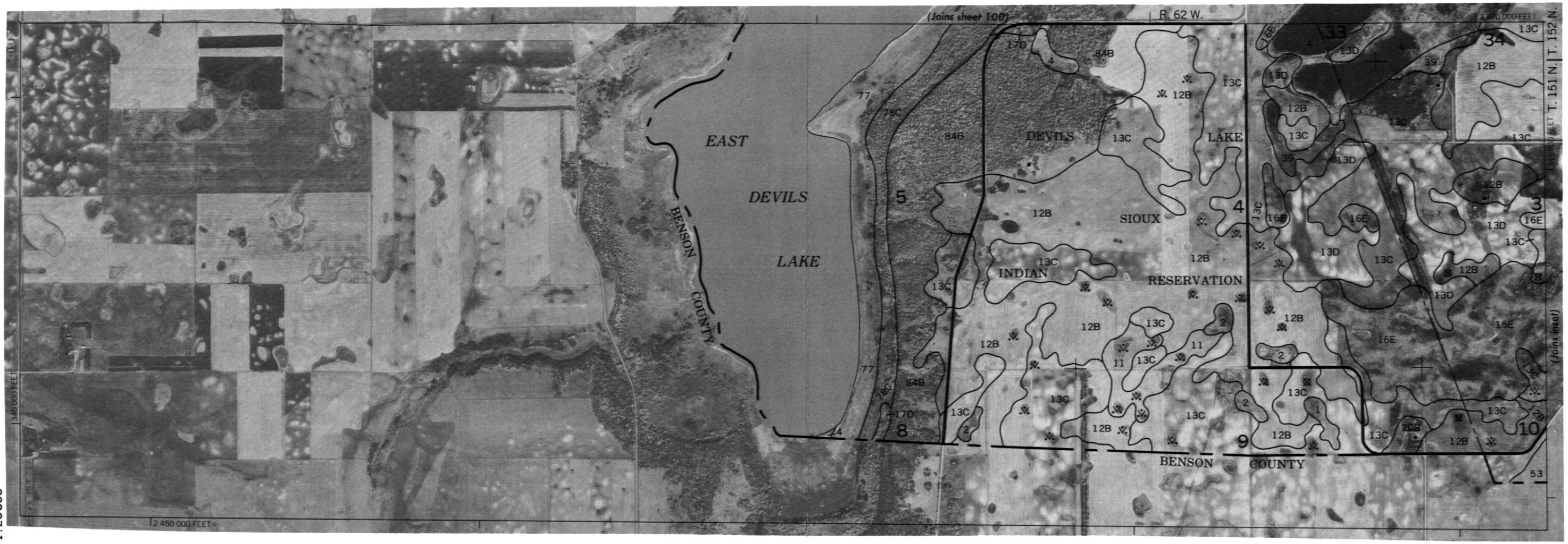
1 Mile

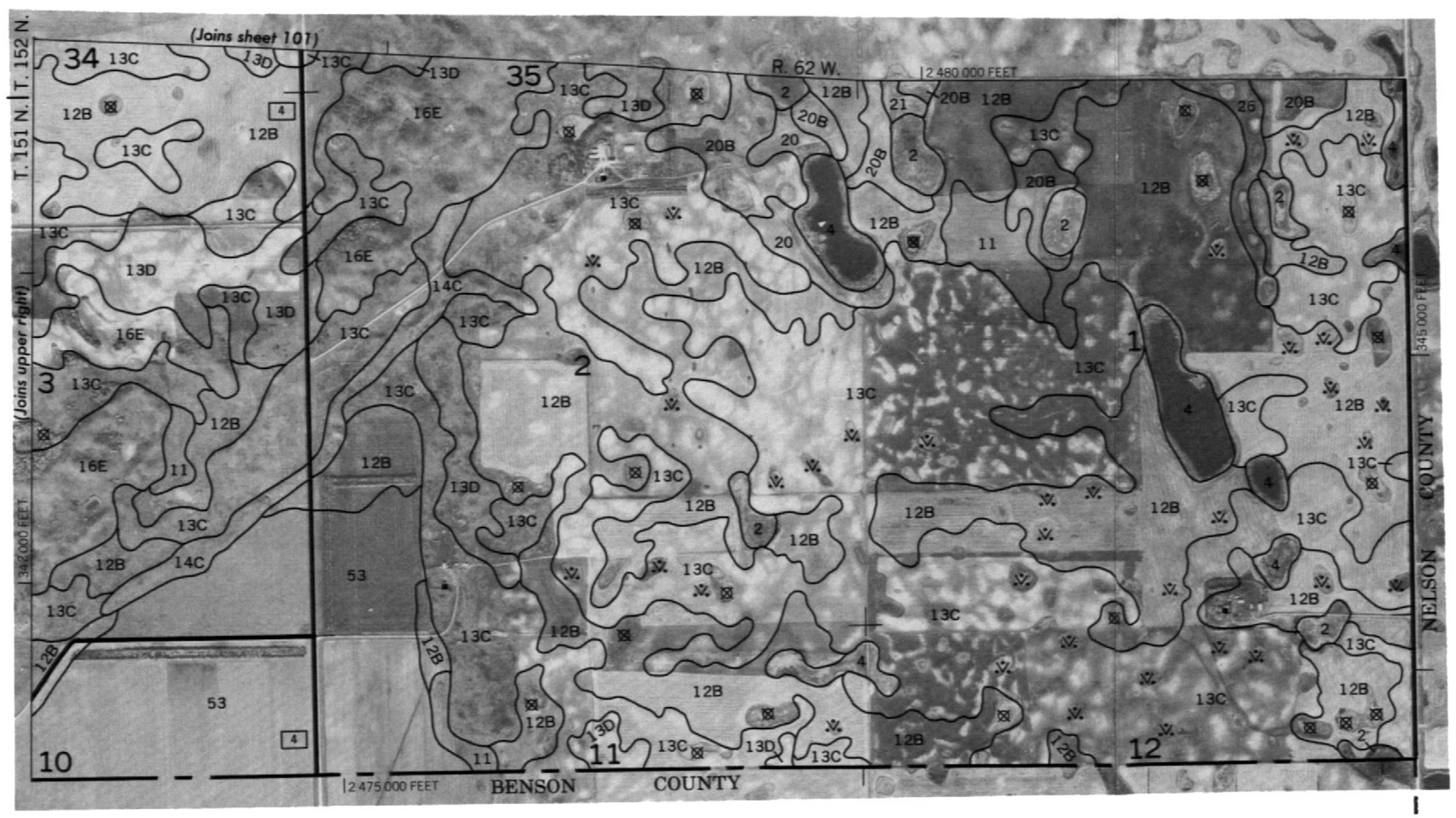
5000 Feet

RAMSEY COUNTY, NORTH DAKOTA — SHEET NUMBER 102

N

1 Mile
5 000 Feet
0 0
1000
¼
2000
½
3000
¾
4000
5000
1
Scale 1:20000





3000 AND 5000-FOOT GRID TICKS

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

RAMSEY COUNTY, NORTH DAKOTA NO. 102